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INTERNATIONAL CONTROL OF ATOMIC ENERGY (I)

ON January 7, 1946, the United States Secretary of State appointed a Committee on Atomic Energy, with Dean Acheson as chairman, to ensure that the American representative on the Atomic Energy Commission of the United Nations Organisation would be properly briefed; this Committee appointed a board of consultants which produced "A Report on the International Control of Atomic Energy"[1], already reviewed in these pages by Prof. M. L. Oliphant (*Nature*, May 25, p. 679). The significance of this report has evidently been appreciated by the British Government, for it has been re-issued by H.M. Stationery Office. The Atomic Scientists Association recently formed in Great Britain has also prepared a memorandum for submission to the Atomic Energy Commission, the recommendations of which in the main follow closely those made by the American Committee. Dr. H. E. Wimperis made a brief study, at the invitation of the Royal Institute of International Affairs, of the impact upon international relations of the new weapons, and has extended it to form a little volume, "World Power and Atomic Energy"[2], in which, after setting the atomic bomb in its true perspective as only one of a series of scientific developments, accelerated by the War, which have been harnessed to war purposes, he reviews briefly the scientific, political, international and ethical aspects. In the purely political field, the Government has introduced its Atomic Energy Bill; and on the ethical plane a commission appointed by the British Council of Churches, under Dr. J. H. Oldham as chairman, to consider the problems created by the discovery of atomic energy, has issued a report[3], in which the moral and ethical aspects in particular are profoundly discussed, even if it is hard to find an answer to many of the questions raised. Thus the Atomic Energy Commission has useful material before it to facilitate its deliberations, on which indeed the fate of civilization may be said to depend.

The report of the British Council of Churches provides material for a reasoned approach to the whole problem, and focuses attention upon the whole question of how men may live freely and well under the pressures of a technical civilization. From the scientific point of view, however, one may well turn first to the American report, around which, as the British memorandum shows, scientific and technical discussion of the problem is likely at the moment to be centred. Moreover, the American board of consultants under the chairmanship of Mr. D. E. Lilienthal, and also the Acheson Committee responsible for it, commend the report, not as a final plan, but as a starting-point for the informed public discussion which is one of the essential factors in developing sound policy. As pointed out by Prof. Oliphant, it provides a really constructive analysis of the question of international control, and a hopeful approach to a solution of the whole problem.

The proposals advanced for the political regulation of the use of nuclear energy are directly related to the

technical character of the invention. There are indeed observations in the report which are of general validity, but the proposals of the Lilienthal Board owe much of their precision and practicability to their limited and defined objective. The searching analysis of early ideas on safeguards, the endorsement of the verdict of the Declaration on Atomic Energy that the only complete protection for the civilized world from the destructive use of scientific knowledge lies in the prevention of war, and the belief in the possibility of establishing new patterns of co-operative effort capable of extension to other fields, must not be allowed to obscure this fact.

The argument of the report is, however, clear, for all that the plan is based on definite technical facts. Technical as well as political, social and organisational problems involved have led the Board first to the unanimous conclusion that there is no prospect of security against atomic warfare in a system of international agreements to outlaw such weapons, controlled *only* by a system which relies on inspection and similar police-like methods. Next, the characteristics of any effective system of safeguards are detailed: the problem of enforcing an international policy against atomic warfare must be reduced to manageable proportions; unambiguous and reliable danger signals must be provided if a nation takes steps that indicate, or may indicate, the beginning of atomic warfare; the plan must, if carried out, provide security and must not be wholly negative, suppressive and police-like; it must be flexible enough to cope with new dangers that may appear in further development of this relatively new field and must involve international action and minimize rivalry between nations in the dangerous aspects of atomic development.

Technically, the problem has definable boundaries, and the Lilienthal Board believes that a system of control which disregards all materials except uranium and thorium satisfies these conditions. Further, it believes that for its limited objective present knowledge in the field of atomic energy is adequate, and it bases its argument on the contention that there are at key points throughout the world of knowledge firm anchorages around which it should be possible to construct an effective and adequate system of control. If here the Board should, in spite of a challenge to test the correctness of its conclusions, appear to be verging on the philosophical field, it has firm support in Bavink's "Anatomy of Modern Science".

It is, however, the next conclusion that leads to the novel features of the plan. It is essential that a workable system of safeguards should remove from individual nations or their citizens the legal right to engage in certain well-defined activities with respect to atomic energy, which will be generally agreed to be intrinsically dangerous because they are, or could be made, steps in the production of bombs. Equally, however, the international authority to which the dangerous aspects of atomic energy are entrusted can only discharge adequately its functions if it is engaged in development and operation. Such a development function also seems to be essential if the international agency is to attract to its service the kind of scientific men and technicians that this problem demands.

For the present purpose it is unnecessary to go further into the nature of the suggested atomic development authority which the Board believes should be set up, assuming that a dividing line can be drawn between dangerous and non-dangerous activities. Although the field is subject to reasonable division, however, the dividing line is not sharp and may shift from time to time in either direction; and for this reason there are certain aspects of the plan which will call for further consideration, particularly from the scientific point of view. Research and development in atomic explosives are enumerated among the activities dangerous for national exploitation, and the research activities of the proposed authority are of particular importance.

The international development authority should not merely seek to extend the field of knowledge in regard to the recovery of raw materials and power development, the design of atomic reactors and separation plant and in all aspects of production, but also it must engage in research which may bear on the application of atomic energy. Even the study of atomic explosives may yield by-products useful in peaceful activities; but the essential reason for the authority conducting research over a wide field is that only in this way can it preserve its position as the best-informed agency, and thus be able to determine where the line between the intrinsically dangerous and the non-dangerous should be drawn, and take appropriate steps to extend the safeguards when necessary. Along with its own research activities, the authority should, however, vigorously encourage research in the universities and public technical agencies, industrial enterprises and research institutes. In particular, to avoid over-expansion of the international authority, the deliberate encouragement of the production of isotopes in national hands is suggested. Indeed, the Board is keenly alive to the importance in this field of research of avoiding unnecessary concentration of functions in the authority.

Related to this question of research is that of the disclosure of knowledge. While the first major activities of the international authority must be directed towards obtaining cognizance and control over the raw materials situation, disclosure of information is an essential first step to international action. One of the elements in the present monopoly of the United States is knowledge, ranging from purely theoretical matters to the technique of production. The Lilienthal Board points out that this information can be put roughly into categories and certain categories divulged at scheduled points; but it stresses the plain fact that unless the United States is prepared to provide the information essential to an understanding of the problem, the Atomic Energy Commission itself cannot even begin the task that has been assigned to it. Further, before the suggested development authority can undertake some of its functions, such as the construction of reactors or the development of power, it will have to spend some time in planning these activities and in research directed towards them; and information must be

disclosed early enough to make such planning and research effective.

While the Board insists on this necessity for sharing information, and concludes with recording the conviction that there can be no international control and no international co-operation which does not pre-suppose an international community of knowledge, it does not advocate indiscriminate disclosure: there are certain types of information which should not be disclosed in the absence of effective international control. It insists none the less that in accepting the plan it recommends for international control, the United States will be committed to making available this information at the time, and in the full measure, required by the operating necessities; and it justifies disclosure in the manner indicated as the only means of achieving the long-term national security of the United States.

It is at this point that the technical aspect of the problem begins to merge into the political and moral aspect. The Lilienthal Board concluded its deliberations on this most difficult problem, not in a spirit of hopelessness but with a measure of confidence and with the conviction that, for the technical reasons already indicated, a satisfactory plan can be developed. Moreover, the simplification of the technical issues simplifies simultaneously the legal and procedural difficulties: infringement of any one of the few specified physical operations declared illegal would be complete evidence of war-like intent. But the confidence of the Board depends largely on some such plan being put into operation before the international atomic armament race attains such momentum that it cannot be stopped. There is a time-factor which is all-important.

It is thus clear that the scientific workers of the United States have taken a most important step in preparing the way for their country to accept the responsibilities of leadership, which possession of so much of the technical knowledge of production in this field lays upon them; and the task of further discussion of these proposals, so far as they concern the government of the United States, and the simultaneous task of educating public opinion in that country in support of the proposed plan or a modification of it is one that they are clearly determined to discharge. But there are like responsibilities that the publication of the report places upon scientific workers in other countries, if the Lilienthal plan or any other scheme of international control is to succeed. Not merely must public opinion be prepared for the surrender of national sovereignty involved: no less important, the scientific and technical aspects of the plan must be searchingly but constructively reviewed, and alternative and constructive proposals advanced to cover any features in which it appears to be defective or unacceptable.

The recommendations of the Atomic Scientists' Association, a body of British men of science who have been associated with atomic energy projects (see *Nature*, **157**, 725; 1946), as set forth in a memorandum on the international control of atomic energy issued shortly after its formation, are on similar lines to those of the Lilienthal Board. An immediate attempt is urged to obtain international agreement by which the use of atomic energy, the distribution of the essential raw materials, and the erection and operation of plants designed to produce or capable of producing active materials, would be strictly controlled by the United Nations Organisation. The control would be implemented by a system of inspection, and all major sources of raw materials and major production plants would be handed over to the United Nations Organisation and operated under international boards responsible to it, and guarded by men also responsible to and appointed by that Organisation. The Atomic Energy Commission should undertake the construction and operation of new large-scale plants for the production of fissionable materials. These plants should be so distributed throughout the world as to ensure that if any nation seize control of plants operating in the area in which its own armed forces predominate, the remainder of the United Nations would jointly possess an overwhelming superiority in the production of fissionable material.

The disposal of active materials produced in such plants and the research, development and production of atomic explosives would be reserved to the United Nations Organisation, and any bombs made in that way or made prior to the scheme should be kept in stores distributed throughout the world. The Association does not commit itself to regarding the atomic bomb as a desirable or suitable weapon for police functions, but considers production and control of atomic bombs by an international authority as essential at present to prevent any ill-disposed nation holding the threat of atomic warfare over the peace-loving nations. The Association is impressed with the feasibility of the division of atomic energy activities into 'safe' and 'dangerous' categories, as suggested by the Lilienthal Board, and the memorandum also includes a recommendation in favour of lifting the secrecy rules and ultimately carrying on all research and development freely and openly, with a duty to report to the United Nations Organisation any significant results.

One first step to which British men of science must address themselves forthwith is the scrutiny of the Atomic Energy Bill and any other legislative or executive measures which the Government proposes to take in this field; so as to ensure that no action is taken which will impede either the work of the Atomic Energy Commission itself or the attainment of international agreement on this difficult question. The powers which the Atomic Energy Bill gives to the Minister of Supply are indeed wide, but they appear to be necessary at present, and should in fact facilitate the handing over of the specified dangerous operations to international authority in accordance with any plan on the lines suggested by the Lilienthal Board. The Bill charges the Minister with the general duty of promoting and controlling the development of atomic energy, as well as its production and use and the prosecution of research. He has power to obtain information concerning any materials, plant or processes connected with the production of atomic energy, including that of entry and inspection of premises, as well as powers of search for minerals

from which uranium and other prescribed substances might be obtained, the right of working and powers of control over the working of any such minerals.

A further clause in the Bill restricts the disclosure, without the consent of the Minister, of information concerning any existing or proposed plant for producing or using atomic energy, the purpose or method of operation of any such plant or process, except plant designed solely for research or educational purposes. This power clearly is required as a preliminary to the ordered release of information. Similarly, the scheme outlined by the Lilienthal Board should remove the fear that scientific research at the universities may be hampered in spite of the specific exception already noted. This is probably the most substantial criticism that can be advanced against the general terms of the Bill; but it needs to be remembered that the Atomic Energy Bill, like similar legislation in the United States, while in one respect preparing the way for an international authority, in itself leaves the matter in the most dangerous position. The dangerous aspects of atomic energy must be taken out of national hands and placed in international hands quickly; and the longer the delay in establishing such an authority the greater the danger, not merely of an uncontrollable atomic armament rivalry between the nations being precipitated, but also the greater the difficulties of the transition period, to which the Lilienthal Board directs special attention.

Here, of course, we are largely entering the political field, as distinct from the technical or scientific, but the man of science or technician has a perfect right to give his views on the political conditions in which any scheme for international control can function successfully. This the Lilienthal Board has done, and there lies upon their fellow men of science the responsibility not merely of scrutinizing the technical aspects of the plan but also of ensuring that those essential political considerations, as well as the broad technical features of the scheme, are fully understood by their fellow citizens. No plan such as is proposed could wisely be undertaken unless there were valid hope that it would be entered into, and carried through, in good faith; and that in itself presupposes public understanding of the indispensable requirements of the plan.

No part of its report is more praiseworthy than that in which the Lilienthal Board endeavours to prepare public opinion in the United States for the implications of any such scheme, and the disappearance of the present monopoly, both in knowledge and in physical facilities. Scientific workers already recognize that knowledge will become general; for the science on which the release of atomic energy rests is essentially a world-wide science, to which men of many countries have contributed, and the principal findings on which the success of the project depends are well known to workers in the field of nuclear physics everywhere. Further, the ultimate balance towards which a plan for international control must work will witness the loss also of material facilities, so that neither in legal possession nor in geographical distribution is any one nation unduly favoured.

But there is one point here that should be made plain. The Lilienthal Board, in proposing an international authority, is using the word in a particular sense—that of a super- or extra-national body. It does not advocate the disclosure of the critical items of fundamental knowledge or of the technique of production to national governments in the way that immediate disclosure to the United Nations Organisation would involve. What it proposes is an impartial body standing outside and above national rivalries and suspicions; and there is sound reason for the United States or Canada or Great Britain declining to impart the essential information of this type to any other body. It seems clear from the Atomic Scientists Association's memorandum that this view is shared by British men of science also, and Dr. Wimperis in his book quotes an emphatic opinion to the same effect from Prof. A. Einstein. Until the individual nations are prepared to renounce national sovereignty to that limited extent, atomic energy will continue to represent the great menace of our age, and its potentialities for good will remain an unsubstantial shadow.

[1] A Report on the International Control of Atomic Energy. Prepared for the Secretary of State's Committee on Atomic Energy by a Board of Consultants, Washington, D.C. Pp. viii+44. (Washington, D.C.: Government Printing Office; London: H.M. Stationery Office, 1946.) 1s. net.

[2] World Power and Atomic Energy: the Impact on International Relations. By H. E. Wimperis. Pp. viii+87+5 plates. (London: Constable and Co., Ltd., 1946.) 6s. net.

[3] The Era of Atomic Power. Report of a Commission appointed by the British Council of Churches. Pp. 84. (London: Student Christian Movement Press, 1946.) 2s. net.

STAFFING OF TECHNICAL SCHOOLS AND COLLEGES

THE first post-war report of the Burnham Committee on the scales of salaries to be paid to teachers in technical colleges and institutes, art colleges and schools, was published in August 1945. The scales recommended in that report by the Committee, which is comprised of representatives of local education authorities and teachers, were approved by the Minister of Education and are in process of application to the staffs of all technical institutions throughout England and Wales which are supported by grants from the Ministry.

The compromise agreement between local education authorities and teachers set out in detail in the report covers a relatively short period of three years from April 1, 1945, and consequently will be due for review before April 1, 1948. It is not, therefore, too early to consider the question of the adequacy of the salary scales, having regard to the vital importance to Britain of the maintenance and development of a highly efficient system of technical education.

Since the Burnham Report was published, the recommendations of the Committee presided over by Lord Eustace Percy on higher technological education in universities and technical colleges have been published. The findings of the Percy Committee make it clear that the higher work carried on in technical colleges, though differing in outlook and objective from that in the faculties of technology of the universities, is by no means inferior to it or of less

importance. They are parallel systems of higher education, both essential in their respective spheres for the scientific and industrial progress of Great Britain. It follows as a necessary corollary that the staff recruited to the larger technical colleges responsible for the higher branches of technology should not be inferior to those of the technological departments of the universities.

This was recognized by the McNair Committee on the Training of Teachers, the report of which, published in 1944, stated that the head of a large department of a technical college is doing work, and has responsibilities as regards organisation and research, comparable with those of a university professor. His maximum salary should be of the order of that of a university professor.

From Circulars recently issued to local education authorities by the Minister of Education, notably Nos. 87, 94 and 98, it is evident that the Minister is prepared to be guided by the recommendations of the Percy Report in the administration of technical education. For example, as recommended in the Percy Report, Circular 87 foreshadows the division of the country into regions for the organisation of further education. Each region is to have a regional advisory council, together with a regional academic board for advanced technology, assisted by advisory committees. The function of the regional academic board is to develop and co-ordinate higher technological studies within the region. Ultimately, a national council of technology is to be brought into being. Upon these bodies representatives of universities, technical colleges and local education authorities will serve. Circular 94 stresses the importance to the industrial progress of Britain of the greater development of research in technical colleges, and makes provision for qualified members of the teaching staff to devote more time to original research than has been possible hitherto. Circular 98 raises the important question of the status of technical colleges, and makes recommendations as to ways and means of increasing the confidence of industry, commerce and the professions in the work of the colleges. It is stipulated that, subject to the ultimate control in matters of finance and general policy by the providing authority, a technical college should enjoy such freedom as will enable the governing body to develop its work in such directions as prove desirable and to attract first-class teachers to its staff. It is added that the provisions of the report of the Burnham Committee on Salaries for Teachers in Technical Colleges, etc., will, the Minister believes, make it possible to offer the emoluments necessary to maintain a high standard of staffing.

This last statement raises an important and crucial issue. It must be said at once that the very comprehensive character of the Burnham scales for technical teachers militates against their effectiveness in the realm of higher technology. The scales for technical teachers have, for reasons which it is not easy to understand, been closely tied to those applicable to teachers in primary and secondary schools. For the large majority of teachers in technical institutions they are in fact identical with them, and only in the provision of separate scales for heads of departments in technical colleges and the introduction of a senior assistant scale for a limited number of technical teachers do they differ from the school salaries. The scales are designed to cover the whole range of further education from the teachers in a small country technical institute to the lecturer in a major technical college, the junior lecturer in which, however advanced and important his work, may be on the same salary scale as the teacher in the smallest institution.

The small addition of £15 to the minimum and of £30 to the maximum of the scale in the case of a school teacher possessing a university degree has been the subject of much controversy. Whatever justification—if justification there be—for making this addition to the graduate school teacher's salary so meagre, there surely can be no justification whatever for so miserly a policy in the case of a technical college lecturer, whose fitness for his job depends in many cases on his possessing a university degree or an equivalent professional, industrial or commercial qualification. It is true that the Burnham Report provides for special additions to the basic scales, of £50–£100 inclusive of the graduate allowance in respect of special responsibility, special academic, professional, industrial or commercial qualification; but similar additions are also available to school teachers, and in many areas more liberally to teachers in secondary schools. The fact remains that some 50 per cent of the staff of technical colleges receive no such additions, but are paid on the basic scale common to all teachers. The salaries of senior assistants and heads of departments in technical colleges range from minima of £600 for men and £480 for women to maxima of more than £1,000 for men and £800 for women. The maxima for heads of departments have been fixed by one large local authority at £1,100 for men and £880 for women. It can scarcely be claimed that these salaries are comparable with the salaries paid to university professors, as recommended by the McNair Report. The minimum salaries paid to university professors are now of the order of £1,500. Moreover, it is understood that the salary to be paid to the principal of one of the largest and most important technical colleges in Great Britain is £1,750.

Insufficient time has elapsed to determine the effect of the Burnham scales on recruitment to the staffs of the major technical colleges, but it must be obvious that considerable improvement will be needed if really first-class highly qualified men and women with suitable training and experience are to be obtained. For the successful development of industry and commerce, the training of key technologists, industrial research workers and commercial experts should be carried on by the most highly skilled and competent men and women available, who must, if they are to be attracted to the teaching profession, receive adequate financial reward comparable with that obtainable in the universities and in industry and commerce.

The commencing salaries of lecturers in departments dealing with higher technology must be such

as will attract highly capable men and women who, by further study and research, will be able to keep abreast of the rapid advances in technological development. The salaries of the higher posts to which they can aspire in the profession must be such as to afford them every encouragement both in their teaching and in the important contribution they can make to technological advancement. Moreover, the buildings in which they work and the facilities provided for both teaching and research must be of the very best.

It is very much open to question whether the administration of higher technical education through local education authorities, occupied as they must be with the vast developments of education in the schools provided for in the Education Act of 1944 and with the wider aspects of further education, can ever meet the future needs of Britain in technology and commerce. The Minister of Education has undoubtedly taken a wise step in calling for the establishment of a national council of technology and regional boards. Upon these bodies there must be the strongest possible representation of both industry and commerce, of the technical colleges, and the universities. The needs of the country must be voiced by these bodies, and ways and means must be found quickly for the large financial provision which will be needed if we are to make provision for the very best technological education it is possible to have. Only the best will do.

The time has surely arrived when technological education should no longer be financed by local education authorities aided by a 50 per cent grant from the Exchequer. Something on a national basis akin to the University Grants Committee is needed to deal with this vital part of the educational system of Britain. The administration and development of the larger colleges should no longer be in the hands of the local education authorities, who have quite enough to do to implement the vast provisions of the Education Act in other spheres of education. The methods of administration most suited to the organisation of schools and the more elementary forms of further education do not lend themselves to the efficient control and development of higher technological education, which requires personnel with suitable special experience at both administrative and executive levels. The larger technical colleges should, like the universities, become autonomous bodies receiving grants direct from a national committee of experts suitably qualified to assess and make provision for their needs. Until the control of the more advanced technological education is made a national concern and is in the hands of those most qualified to deal with it, we cannot expect that progress for which the country waits.

A sound system of technological education in Great Britain is a matter of fundamental importance to industry and commerce, and doubtless once it is under efficient national control there will be no lack of grants forthcoming, from private benefactors and from large industrial and commercial undertakings for specific purposes, similar to those received by the universities.

INDUSTRIAL USES OF NATURAL FATS AND FATTY OILS

Industrial Oil and Fat Products

By Alton E. Bailey. Pp. x+735. (New York: Interscience Publishers, Inc., 1945.) 10 dollars.

NATURAL fats and fatty oils derived from vegetable and animal sources are used annually to the extent of many millions of tons in a variety of industries which may be classified in three broad groups: (*a*) the edible-fat industries (dairy butter, margarine, cooking fats, confectionery fats); (*b*) the manufacture of detergents (soaps of various types, sulphated higher fatty alcohols and other detergents which are not simple alkali salts of fatty acids); (*c*) the manufacture of paints, varnishes, leather coverings or fillings, linoleum, certain plastics, etc., which depend upon the transformation of certain (unsaturated) fatty oils to colloid-like solids by oxidation and/or polymerization.

The technical processes and plant involved in these different applications of natural fats are many in number and often intricate and elaborate in design. This is perhaps the reason why many monographs on the fat industries are almost entirely occupied with detailed considerations of processing and plant construction, but have frequently paid remarkably little attention to the two features of obvious fundamental importance in a natural raw material. These features are, first, the chemical constitution of the natural products; and secondly, the attention which should be given to correct handling of these products in order to avoid deterioration during collection, transport and storage prior to extraction and utilization of the fat.

Many elegant rapid methods for the evaluation of the average characteristics of technical fats had been developed, but knowledge of their precise chemical structure was on the whole very deficient up to about twenty-five years ago. In 1924 the late Dr. E. F. Armstrong described the fats as "a neglected chapter in organic chemistry" in a presidential address to the Society of Chemical Industry, which doubtless stimulated research in this field. Certainly the constitution of natural fats is much better understood to-day; and in the United States, perhaps more than elsewhere, several centres of investigation have become known for their active work in fat chemistry.

The other feature mentioned—conservation of quality—is still too often overlooked. Many of the fat resources which Britain uses are tropical in origin. Consequently, although the fats produced in Nature are almost wholly pure triglycerides, they are liable rapidly to become rancid by enzymic hydrolysis and oxidation, unless the urgent need for guarding against such deterioration is well appreciated at the centres of collection of the raw material. Those concerned with the reception and distribution of imported fats and oil-seeds in Britain at the present time will not need to be reminded of this unfortunate condition of affairs. At any time the depreciation in value of fats produced in a high state of purity by natural processes is unnecessary and unfortunate; in periods of economic stress, it adds heavily to the burden of the manufacturer and to the difficulties of the consumer. In the whaling industry this aspect has been efficiently dealt with by use of the modern 'factory' ship; the plantation palm oil industry is also being developed with careful regard to preserva-

tion of quality of the fat. It is urgently necessary that equivalent technical attention should be given, particularly *at the centres of collection and transport where the damage sets in*, to similar problems in connexion with many oil-seeds grown in different parts of the British Commonwealth, especially in the tropics.

Dr. Bailey's monograph does not suffer from the above-mentioned failings of some earlier handbooks. Throughout, his treatment of the applications of fats in industry is considered in relation, primarily, to their chemical structure; and the main part of the work is preceded by very adequate chapters on the general chemistry and biochemistry of the fats. A comprehensive survey of the chief fatty raw materials in relation to their annual production and consumption next follows, before their industrial utilization in edible fats, detergents or paints and related products is systematically discussed. The final section of the volume (260 pp.) is devoted to the 'unit processes', that is, the general methods of extraction, refining, hydrogenation, hydrolysis, soap-making, etc., in use at present; this part of the work deals with the technological aspects which, as has been said, were prone to occupy nearly the whole of the older monographs on this subject.

The treatment in each of the four main sections is admirable, and the work is written throughout in a very concise but fluent style. The type and illustrations are clear and the publishers deserve recognition for an excellent piece of work. The volume is definitely in advance of earlier works on this subject, and will be valuable to the technologist and to others whose interests lie in the province of the natural fats. Naturally, the book is written from the point of view of the American industries, but in this respect it is by no means narrowly conceived. Indeed, where the fundamental background of the subject is involved, Dr. Bailey has drawn widely upon published literature, and has given full appreciation to all the scientific workers who have contributed to the modern understanding of natural fats.

On the industrial side, more space is allotted to the edible fat industries than to those concerned with detergents and with paints, varnishes, etc. Since, however, the latter are adequately covered, this allocation of space may have been determined by the relative importance of the respective industries in the United States rather than by the author's personal predilection. The importance of care in preventing deterioration in oil-seeds, referred to earlier, is not stressed as much as might be desired; but here the author has evidently had in mind chiefly the American conditions in which oil-bearing crops are cultivated on a large scale, and the problem of collection and storage by Colonial peoples is less prominent.

Again, there are inevitably differing views as to where the line should be drawn in regard to the extent to which fundamental theory is developed in a volume of this kind, and also in regard to how much of the most recently published data (especially on new technical processes) is likely to endure. For example, some might feel that the theoretical discussion of hydrogenation and heterogeneous catalysis is somewhat more extensive than necessary for the purpose of the readers of this book, whereas that on the mechanism of oxidation and polymerization of unsaturated glycerides, and possibly that on the physical chemistry of soaps, is less fully treated in comparison with the former. Again, certain products and processes which have been widely publicized of recent years find a place in the volume, admittedly with reservation as to the likelihood of their proving to be permanent in value. It is extremely difficult, in a book dealing with modern applied chemical industry, to decide the limits of inclusion or exclusion in regard to both the topics which have been mentioned. It is a matter for the author's discretion, and in this book Dr. Bailey has, in my opinion, made on the whole an excellent choice. The volume is thoroughly up to date and errs, if at all, on the side of catholicity rather than exclusion.

"Industrial Oil and Fat Products" is a very good exposition of its subject, well produced and well indexed, and a desirable addition to the scientific literature in this field.

T. P. HILDITCH

ROLE OF SCIENCE IN THE DETECTION OF CRIME

Forensic Chemistry and Scientific Criminal Investigation

By A. Lucas. Fourth edition. Pp. 340. (London: Edward Arnold and Co., 1945.) 25*s*. net.

A Scientist in the Criminal Courts

By Dr. C. Ainsworth Mitchell. Pp. viii + 144. (London: Chapman and Hall, Ltd., 1945.) 8*s*. 6*d*. net.

THE widespread popularity of detective fiction has rendered familiar to a considerable section of the general public the contribution the man of science may make to the detection of crime. In detective novels, however, the crime of murder is that most frequently utilized as the basis of the plot, a natural enough choice in view of its 'thriller' value, although it should be realized that the majority of the murders committed, in Britain at any rate, are dull and sordid crimes and entirely devoid of subtlety.

What is not so often realized is that the chemist, the biologist and the physicist frequently give the investigating officer material help of various kinds in the detection of the larcenies, housebreakings and other everyday crimes which, though they do not make 'news', are probably of much more concern than murder to the ordinary, decent citizen.

The two books under review, although very different in scope, both give some idea of the wide range of scientific assistance which is now available in criminal investigation.

Although that by Lucas is much more general in character, it is interesting to note that the fullest and, in the opinion of the reviewer, the best chapters reflect the nature of the author's experience as a forensic chemist in Egypt. His introductory chapter on the collection, packing and systematic examination of material by the expert is altogether admirable, as are the long chapters dealing with documents, firearms and poisons, although this last might well have included a fuller treatment of the barbiturates, which to-day constitute a very important group of drugs, and might also with advantage have given the method of determining the alcohol content of blood and urine.

Some of the shorter chapters are rather scrappy and inadequate, notably those dealing with bloodstains, with various types of dust, dirt and glass, with microscopy and photography, and with fibres of various kinds. It is doubtful whether any really

useful purpose is served either by these or by the short chapter on fingerprints, footprints and the tracks of vehicles, since the study of these is essentially a matter for the police expert. The production of a really comprehensive and adequate book on the wide range of material covered by forensic scientists is probably beyond the powers of any one expert, and it would be much more satisfactory to have either fuller specialist contributions by individual experts or a series of books each dealing in much more detail with the material and technique of his own subject.

Dr. Ainsworth Mitchell has not aimed at writing a text-book but rather at presenting to the public some of the more interesting facets of the work in which he is acknowledged to be a leading authority. The detailed application of an expert knowledge of various types of inks and paper to the solution of a wide range of forensic problems, from disputed wills to forgeries, anonymous letters and secret writings, is admirably illustrated by actual case work, and it is noticeable that the facts are presented, as they should be, with scrupulous impartiality. It is an eminently readable and human book and any member of the public who has had to attend court either as a juror in waiting or as an ordinary, as distinct from an 'expert', witness will agree with his observations as to the discomfort to which the members of the public are subjected. The majority of the assize courts are out of date buildings in which no provision is made for even the most elementary comforts. The relatively lucky ones spend hours sitting on plain wooden seats reminiscent of the mid-Victorian board school: the less fortunate are herded into cold stone-flagged corridors or ill-ventilated witness rooms with fewer amenities than the waiting-room at a rural railway station. The sanitary arrangements are frequently grotesquely inadequate and means of obtaining reasonable refreshment in the limited period of the luncheon adjournment non-existent.

It should not be beyond the wit of man to secure decent treatment for the citizens who are performing a public duty, often at great personal inconvenience, on behalf of their fellows. H. S. HOLDEN

BIRDS IN ANTARCTICA

B.A.N.Z. Antarctic Research Expedition, 1929–1931 Reports, Series B (Zoology and Botany). Vol. 2: Birds. By R. A. Falla. Pp. xiv + 288 + 4 plates. (Adelaide: Barr Smith Library, University of Adelaide, 1937.) 50*s*.

THE Report by R. A. Falla on the birds listed during the British, Australian and New Zealand Antarctic Research Expedition of 1929–31, under the command of Sir Douglas Mawson, was issued in 1937; but copies of it have only recently reached Britain. In the report Falla has also included records, compiled by H. Hamilton, of the birds noted during the Australasian Antarctic Expedition of 1911–14 the publication of which had been fatally interrupted by the War of 1914–18. Although Falla has drawn extensively upon the observations of the earlier expedition, the records are incomplete owing to losses of some of the original data, skins and eggs.

The Expedition of 1911–14 included three antarctic summer cruises and two sub-antarctic winter cruises in the S.Y. *Aurora*; two years continuous shore work by a party at the Main Base at Cape Denison, King George V Land; one year's work by a party at the Western Base, Queen Mary Land; and two years work by a party on Macquarie Island. Extensive field work in ornithology was conducted and was shared by a number of biologists. Their observations have been supplemented by notes made by Sir Douglas Mawson during this and the First Shackleton Expedition of 1908 and by accounts made on the Second Shackleton Expedition of 1915–16 and the Shackleton Relief Expedition to the Ross Sea in 1916–17.

During the Expedition of 1929–31 no permanent land bases were established, and work was carried out from the S.Y. *Discovery*. Continuous observation and a limited amount of collecting were done at sea and in the pack-ice, and shore work was carried out at the following localities: Crozet Islands; Royal Sound, Kerguelen; Atlas Cove, Heard Island; Cape Batterbee, Enderby Land; Macquarie Island; Cape Denison, King George V Land and the coast of MacRobertson Land. The biological work of the expedition was under the general direction of Prof. T. Harvey Johnston, and Falla was responsible for all ornithological records. Altogether, the complete bird collection consisted of 300 skins, 67 spirit specimens, 105 eggs, samples of stomach contents and of stomach oils, in addition to photographs, sketch books and field notes.

The Report, which is admirably presented, contains a general account of the birds of the region, including the Southern Ocean—the oceanic area bounded on the north by a line joining the southern extremities of South America, South Africa, Australia and New Zealand, and on the south by the Antarctic Continent—the Crozets, Kerguelen, Heard and Macquarie Islands, the pack-ice and the Antarctic coastline. The abundance of species and individuals in the region is described in detail and the author confirms the well-established point of the restriction to this area of practically the whole order of penguins and some of the families of petrels.

Most of the Report, however, is made up of a systematic account of each of the bird species represented in the collections or noted during field observations. In all, sixty-nine species are described and include representatives of the eight orders, Sphenisciformes, Procellariiformes, Pelecaniformes, Lariformes, Charadriiformes, Anatiformes, Ralliformes and Passeriformes. The taxonomy has been based on James Lee Peter's "A Check-List of the Birds of the World" and alterations and amendments have been made only when they seemed warranted by the good series available, fuller field data, or more extensive observations. This applies more particularly to the rejection of described sub-species or the proposal of new ones; decision in such cases was based not only on an examination of specimens but also on consideration of such habits as date of breeding and migration.

The Report is illustrated by 216 photographs which have been carefully chosen and alone make the work an outstanding contribution to systematic ornithology. These are supplemented by four coloured plates of the highest quality. There are also three appendixes, the first, by Sir Douglas Mawson, dealing with the body measurements of certain antarctic species and their weight in pounds per square foot of the wing and body, and the other with the lists of official collections of both expeditions.

A Class Book of Practical Embryology

For Medical Students. By P. N. B. Odgers. (Oxford Medical Publications.) Pp. 64. (London, New York and Toronto: Oxford University Press, 1945.) 7*s.* 6*d.* net.

EMBRYOLOGY is a particularly difficult branch of anatomy for the medical student to tackle, since it involves a correlation of a time process with a sense of form. The student must learn to appreciate the shape of an organ from the examination of a series of sections, and many never succeed in developing this faculty to any extent. The ideal method of study—the preparation and examination of sections of embryos, and the construction of wax models of organs—cannot be applied to the ordinary medical student because of the time involved. A good compromise is to allow the student to study certain carefully chosen sections of an embryo, so that he can work out the form of any organ at one stage in its development at least. In this book Dr. Odgers has used twelve sections of a 6-mm. pig embryo, and fifteen sections of a 10-mm. pig embryo. The study of these two pig embryos forms part of the course in embryology at Oxford. Each section used is drawn on a large scale, the figures consisting of line drawings illustrating only the more obvious features of each section. The accompanying descriptions are sufficiently full for the purpose. Attention may be directed to the appropriateness of the diagram to explain the formation of the terminal portion of the inferior vena cava. This book should fulfil its function and be of assistance to anyone who desires to gain first-hand experience of the examination of embryological sections.

Organic Preparations

By Prof. Conrad Weygand. Translated and revised from the German Text. (Published and distributed in the Public Interest with the consent of the Alien Property Custodian under Licence A-6.) Pp. xiii + 534. (New York: Interscience Publishers, Inc., 1945.) 6 dollars.

THE German original of this text was published at Leipzig in 1938 as Part 2, "Reaktionen", of Prof. Weygand's "Organisch-chemische Experimentierkunst". Part 1 dealt with materials and operations, and Part 3 with the chemical and physical analysis of organic compounds; the publishers do not propose to issue an English translation of these two parts.

Part 2 affords a comprehensive and useful review of a very large variety of organic reactions, as conducted in the laboratory. Exact working details are given, and there are numerous references to original papers and to "Organic Syntheses". The reactions are arranged in thirteen chapters, according to the formation and fission of the many kinds of linkages characteristic of the carbon atom. The result is a thorough and reliable treatment of the subject. In the main, the account was up to date at the time of the original publication (1938); but there are some noteworthy lapses. Thus, no mention is made (p. 69) of the important method of forming halogenohydrins by the action of chlorine water or bromine water on ethylenic compounds; it is startling to read (p. 146) that *l*-menthol may be oxidized to *d*-menthone by means of a modified Beckmann reagent; and, in the experience of the reviewer, the conversion Ar·CHBr·CHBr·COOH → Ar·C:C·COOH (p. 327) may be greatly simplified by treating the dibromide directly with hot 50 per cent aqueous potassium hydroxide. J. R.

Statistical Thermodynamics

A Course of Seminar Lectures delivered in January–March 1944 at the School of Theoretical Physics, Dublin Institute for Advanced Studies. By Erwin Schrödinger. Pp. vii + 88. (Cambridge: At the University Press, 1946.) 6*s.* net.

Elementary Wave Mechanics

By Prof. W. Heitler. Pp. viii + 136. (Oxford: Clarendon Press; London: Oxford University Press, 1945.) 7*s.* 6*d.* net.

BOTH these books are reprints from hectographs published by the Dublin Institute for Advanced Studies, and both have been reviewed in this periodical, the first by myself (*Nature*, 154, 782; 1944), and the second by Prof. H. T. Flint (*Nature*, 154, 101; 1944). I have nothing to add to my previous article.

Heitler's book has been extended by adding two chapters (8 and 9) on the quantum theory of the chemical bond and valency. They give an excellent account of this difficult subject. All essential ideas are not only mentioned but really explained. The little book is a remarkable achievement of the art of clear and condensed writing and can be warmly recommended. MAX BORN

How Life is Handed on

By Cyril Bibby. Pp. vii + 96. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1946.) 3*s.*

OFFICIAL recognition by the Ministry of Education that instruction in sex matters should be included as a normal part of the school programme has led to a growing demand by teachers and parents for books which could be used as readers by children. For children aged about eleven years this book would be eminently suitable, both for its simplicity of style and absence of moralizing. The living kingdom is dealt with as a whole and all references to human reproduction and sex behaviour are carefully arranged to make them fit naturally into the text. There are many illustrations which are apt and well drawn, while three useful appendixes are concerned with the answers to questions which children frequently ask, further reading matter and a simple glossary. Exception might be taken to some of Bibby's dogmatic answers to questions on the grounds of unsubstantiated evidence, but even here he has erred on the human side to reassure children about certain fears which often do much to interfere with healthy development.

Great Adventure

Pioneer Studies for Action in Education. By N. and J. H. Higginson. Pp. x + 136. (Bickley: University of London Press, Ltd., 1945.) 4*s.* 6*d.* net.

LITTLE need be said of this book. It is a work of faith revealing the authors' belief in and readiness to work for the educability of the common man and woman. Over the past few years they have taken some part in rural adult education, in the vocational training of young people at one of the Government's training centres, in the educational schemes which have made considerable progress in H.M. Forces during the War, in the service of youth, in educational broadcasting and other experiments in all-embracing education for adults. Mr. and Mrs. Higginson's book is a record of their work and, although slight and occasionally racy, distils enthusiasm and humility which will be a source of encouragement to other workers in the increasingly important field of adult education. T. H. HAWKINS

ATOMIC ENERGY AND ITS IMPLICATIONS

TWELVE discourses given by scientists and economists of the first rank were delivered at a symposium arranged by the American Philosophical Society to discuss "Atomic Energy and its Implications"; they have now been published*. Four of these are purely physical: "Fifty Years of Atomic Physics", by H. D. Smyth; "Resonance Reactions", by E. P. Wigner; "Problems and Prospects in Elementary Particle Research", by J. A. Wheeler; "Methods and Objectives in the Separation of Isotopes", by H. C. Urey. One by R. S. Stone deals with the health protection activities of the plutonium project. E. Fermi contributes a fascinating account of the development of the first chain-reacting pile, leading up to the historic event of December 2, 1942, when on the removal of about eight feet of the last cadmium strip, "the [neutron] intensity started rising slowly, but at an increasing rate, and kept on increasing until it was evident that it would actually diverge". Nuclear energy had for the first time been produced in appreciable quantities under human control. Fermi says that this first successful pile in the squash court at Chicago University proved exceedingly easy to control. "All the operator has to do is to watch an instrument that indicates the intensity of the reaction and move the cadmium strips in if the intensity shows a tendency to rise and out if the intensity shows a tendency to drop." The strips operate by absorbing neutrons which would otherwise multiply by causing fission in uranium nuclei, and so preventing the chain reaction from becoming diverging.

The remaining six papers, by the natural scientists, J. R. Oppenheimer, Irving Langmuir and A. H. Compton, balanced by the social scientists, J. H. Willits, J. Viner and J. T. Shotwell, form a group dealing with the political, social and moral implications of nuclear energy and in particular of the 'atomic bomb'. It is interesting to compare the views taken by the two sets of men of the possibility of some world government arising in time to stop atomic wars. It is not perhaps unnatural that those whose business it is to deal with human reactions should see the difficulties more clearly than those who work with dead matter, which because it is unreasoning is never unreasonable. In fact two at least of them, Langmuir and Compton, seem convinced of the possibility: "The answer is rather to outlaw war itself. And this can be done by a strong world 'police' which has at its disposal more powerful weapons than any recalcitrant nation can hope to acquire" (Compton). "The proposed solution of the problem of the atomic bomb involves essentially a voluntary limitation of sovereignty of powerful nations to the degree necessary to form a world government capable of preventing war. The difficulties are great but the penalty for failure is world disaster" (Langmuir). Set against these the professionals in social relations: "To remake the constitution of the world and place within it an absolute authority for the prevention of war and its greatest weapon, the atomic bomb, involves so many unsolved questions that those who propose settling it all by a single formula are really but adding confusion to our thinking" (Shotwell); "I am forced to the conclusion that the only conceivable ways in which the world even in theory could be effectively organized so as to assure peace are not available now" (Viner); "I see no hope of world government by formula" (Willits). The expert is not always right, but it is to be feared that this view is more realistic than the former. Yet none is hopeless of a gradual move towards conditions which will make the misuse of this new power less likely, and most stress the possibilities of the United Nations Organisation. The symposium occurred before any of the detailed proposals for control were put forward, particularly those of the Acheson–Lilienthal report, but the whole trend of the papers is in general sympathy with such action. It is not a little remarkable that public opinion in America should have shown itself so willing to accept the very great sacrifices required of the United States in the latter proposals. This broad-mindedness is one of the most hopeful aspects of a difficult situation. The trouble is, of course, that those nations which will submit to restraints do not need them, whereas those that need them will not accept them.

Some of the writers consider the military consequences of the new weapon. It is obvious, of course, that the chief targets will be an enemy's cities, at least until the bombs are much commoner than they are at present. It is less obvious whether the bombs are likely to be an incentive to a sudden treacherous attack, or a deterrent from war altogether. A sudden attack, an atomic 'Pearl Harbour', might indeed break an enemy's morale but it would scarcely destroy his stock of bombs, which are certain to be well shielded and well dispersed. Retaliation might well come from a beaten nation like a bite from a dying viper. It seems to the present writer that the main effect of the possession of atomic bombs by an enemy will be to cause the evacuation of all the principal cities, and this even if the bombs are comparatively few. If the cities are evacuated, their destruction would serve no military purpose and only waste bombs, though one might be dropped occasionally to stop the people from coming back. How far existence would be possible without big cities will depend mostly on the preparations made for it in time of peace. Such preparations, at least up to the planning stage, should now be considered the most important part of any scheme of national defence, especially for Great Britain. They will probably include well-dispersed stocks of food.

It is now time to refer to the most striking of this very able series of papers—that by Dr. Oppenheimer. He is profoundly impressed by the shock which this use of its results has given to the moral justification of science. One is tempted to quote too extensively from this very moving address, but the following expresses it better than any paraphrase: "We have made a thing that by all the standards of the world we grew up in is an evil thing. And by so doing, by our participation in making it possible to make these things, we have raised again the question of whether science is good for man, of whether it is good to learn about the world, to try to understand it, to try to control it, to help give to the world of men increased insight, increased power. Because we are scientists, we must say an unalterable yes to these questions: it is our faith and our commitment, seldom made explicit, even more seldom challenged, that knowledge is a good in itself, knowledge and such power as must come with it." Dr. Oppenheimer sees the discovery of atomic energy with its threat to all the peoples of

* Symposium on Atomic Energy and its Implications, *Proc. Amer. Phil. Soc.*, **90**, No. 1. (Philadelphia, Pa.)

the world as an opportunity, unique and challenging, the opportunity to make peace lasting. He believes in a radical solution, but he recognizes that it cannot evolve rapidly; the first steps will inevitably be very modest. Yet in this way alone, he feels, can the faith of science be preserved, the belief in the unqualified value of knowledge and scientific progress.

As a sequel to an interesting and authoritative account of the methods of isotope separation, Urey discusses the motive of such work, strongly maintaining the value of an understanding of natural phenomena for its own sake apart from its usefulness in peace or war. Wheeler gives a stimulating survey of the present knowledge of elementary particles and the prospects for research. In considering the production of high-energy particles, he points out that it would save much scientific man-power if the proposed National Science Foundation would place a contract with a commercial electrical concern for the development of an accelerator. Certainly, in the past a great deal of the best scientific brains have gone to making machines, leaving diminished energy to use them.

The whole pamphlet is full of stimulating ideas and is well worth careful study. G. P. THOMSON

ECOLOGY AND THE STUDY OF CLIMATE

ON May 15 last, a joint meeting of the Royal Meteorological Society and the British Ecological Society was held in the rooms of the Royal Society, Burlington House, at which a series of papers on the relation of ecology to climate was read. The importance of a proper understanding of climatic factors for the elucidation of many ecological problems needs no stressing: nor does the inadequacy of the climatological data usually available at present, particularly when information is needed with regard either to local climates as determined by topographical variations, or micro-climates arising within particular types of vegetation. This meeting was organised as a means of bringing meteorologists and ecologists into closer touch with each other and with problems which have aspects of interest to each and which cannot be solved satisfactorily without their co-operation.

Mr. G. Manley (president of the Royal Meteorological Society) began the discussion with a paper on "Variations in the Length of the Frost-free Period". He stressed the importance of using measurements of temperature obtained under comparable conditions when making comparisons of the length of frost-free periods in different situations. Minimum temperatures taken within a Stevenson screen are, he considers, much more satisfactory for purposes of comparison than grass minimum temperatures, even when these are taken under standard conditions over short grass. This is largely because of the more closely regulated method of exposure within a screen as compared with exposure over short grass in the open. Mr. Manley then gave four interesting examples showing the effect of variations in topography, or soil, on the frequency and severity of night frost, using data obtained from the Monthly Weather Reports of the Meteorological Office. The relatively frosty character of a situation within a narrow and constricted river valley was demonstrated by comparing temperatures taken at Ushew in County Durham, on a hill above the Weir valley, with those taken at Houghall at a point within the valley, 300 ft. lower in elevation: Houghall was, on the average, about 5° colder on frosty nights than Ushew. In the second example, the station at Malvern was compared with that at Perdiswell on the plain below; the lower station again experienced much the more severe frosts. The importance was stressed of the narrow knife-like ridge of the Malvern Hills as providing a poor collecting ground for cold air on nights when radiation frosts occur, since the severity of night frosts partly depends on the size of such collecting area. In the third example, a comparison was made between two different soil types, one the gravelly loam which occurs at the University Farm, Cambridge, and the other the light sandy soil at the station at Lynford, on the Breckland in Suffolk. The topographical formation is very similar at both places and there is no great difference in elevation. Frosts are, however, much more severe and frequent at the Lynford station than at Cambridge. This is largely to be explained by the relatively low heat-capacity and conductivity of the loose sandy soil at Lynford. The fourth example made a comparison of temperatures within and outside a town by comparing the station in Oldham with that at Barton airfield outside the town; in accordance with common experience, the latter proved to suffer very much the more severe frosts. If, using screen minimum temperatures, the frost-free period of the year is determined, its extent will be related to the local climate of the particular situation. Its extent is thus about four and a half months in a relatively low-lying situation in the Midlands, but may be extended for a further four weeks in a more favourable topographical situation. On the other hand, the frost-free period at Lynford on the sandy and frosty Breckland is only just over two months. Finally, Mr. Manley demonstrated the secular trend of minimum temperatures through the last hundred and fifty years. It would appear that in the winter months of January and December frosts are rather less severe than they used to be, but that there has been little or no change in the severity of spring and autumn frost. This agrees with observations made in Scandinavia.

Mr. Manley's paper provided an excellent prelude to the short discussion given by Mr. W. R. Day (Imperial Forestry Institute, Oxford) on "Local Climatic Effects in Tree Growth". In this he referred to the two factors, frost and exposure to wind. Mr. Day stated that the commonly grown larger trees which suffer from frost injury to any serious extent fall roughly into two groups. There are the species, of which European larch and Corsican pine are the most important examples, the growth-cycle of which is markedly out of phase with the annual seasonal cycle. These either begin growth much too early, as with European larch, or continue growth until much too late, as with Corsican pine; and because of this they suffer seriously from frost in many situations. Then there are also the species which naturally would occur late in the woodland succession and so regenerate under conditions in which previously established vegetation would provide an appreciable amount of shelter from frost, but which are used, for economic purposes in forestry in Great Britain, for making plantations in areas where no such shelter exists. Oak, ash, beech, the spruces and Douglas fir belong to this group. The 'out-of-phase' species suffer the more consistently and severely from frost injury, in suitable situations, and this tends markedly to restrict the areas within which they can be grown

successfully. The species of the second group usually suffer severe and widespread frost injury only at intervals. Thus the years 1927, 1935 and 1945 were all marked by widespread frost injury, in which such a species as Sitka spruce suffered severely in the more frosty situations. These years of widespread frost injury seem to occur either when severe frost follows after a warm early spring has induced susceptible species to flush early, as in 1945, or when it occurs late in May when most species of tree have begun to grow.

The topographical situation is of great importance in determining the severity of frost injury; the examples given by Mr. Manley provided excellent instances of this. A further factor of great importance is the form and density of the vegetation which covers the ground. Dense shrubby growth, such as is provided by young plantations, prevents the light winds, which blow on frosty nights, from disturbing the cold air lying within it and also prevent its drainage to lower levels. The severity of frost injury in plantations thus tends to increase after planting until the thicket stage has been reached: later, when a high canopy has been formed, it may decrease appreciably. Lastly, the elevation above sea-level at which any topographical formation occurs influences the severity of frosts. On the whole, the higher the elevation the more severe the injury, other things, including the condition of the susceptible species of tree, being equal. The above observations were based on the occurrence of frost injury in the field, as identified by its morphological characteristics and by the anatomy of affected tissues. It is very rarely that the temperature conditions under which damage occurs are known by actual measurement *in situ*.

Mr. Day then discussed the effect of exposure to wind on tree-growth. The intensity of exposure is at present estimated qualitatively by foresters and in a highly subjective manner. The data available show that rate of height-growth decreases as intensity of exposure increases, but there are many anomalous observations such as, for example, fast-growing and tall trees recorded as occurring in fully exposed situations. Also, especially in hilly regions, soil fertility often decreases as intensity of exposure increases; but any quantitative estimate of their relative effect on rate of growth is at present impossible, if only because exposure is never estimated quantitatively. The effect of regional topography on the increase in exposure with increasing elevation becomes plain if sample plot data are carefully examined. Thus if the data for European larch in the inland and mountainous counties of Radnor and Brecknock are compared with the data for the coastal and less hilly counties of Carmarthen and Cardigan, it is apparent that whereas in the latter region the proportion of exposed plots increases rapidly with increasing elevation, the increase is comparatively slight in the former. The importance was stressed of obtaining quantitative estimates of climatic factors affecting growth, especially in connexion with the analysis of the relationship between the rate of growth of tree species and their environment.

Prof. D. Brunt (president of the Physical Society) then read a paper on "Some Factors in Micro-Climatology". He stressed the importance of stating in the simplest possible terms the manner in which differences in micro-climate arise. The most important facts concerning micro-climates are related to the absorption of solar radiation by day and the loss of heat by outgoing long-wave radiation by night. The reaction of the earth's surface as an irradiated or radiating body depends on its condition. This is usually complex, especially when there is a covering of vegetation: it is simplest in the case of bare soil. The factors which influence the temperature of the earth's surface and of the air immediately overlying it were then discussed; for example, the wetness or dryness of the surface; its reflecting power; the conductivity and heat capacity of the material lying immediately below the surface; and the vapour pressure of the overlying air. It is, at present, not possible to say very much about the influence of these factors, except in a very general way. This is partly because of the variety and complexity of conditions which are possible with different types of vegetation, but also because of the great lack of accurate observations relating to specific conditions. Types of temperature gradient which occur above the soil with different types of vegetation were then illustrated by data relating first to a flower-bed (antirrhinums), then to a wheat-field and lastly to high forest. Two very important factors in determining the type of gradient occurring are: first, the position of the insolated, or radiating, surface; and secondly, the efficiency with which the physical structure of the vegetation prevents the movement of the air within it. The latter point was well illustrated by the conditions prevailing within a mature wheat crop, where the dense mass of stalks largely prevents free movement of air, so that a greenhouse effect develops from the continuous heating throughout the day of a relatively unchanged atmosphere. Because of this, the lowest temperature during the night is not at the soil surface but about midway up the corn stalks. Owing to the inadequacy of the data at present available, the temperature gradients discussed must be regarded as illustrating general types only.

Dr. G. C. Evans then read, on behalf of Dr. P. W. Richards and himself, a paper on the "Climate within a Tropical Rain Forest". The observations brought forward were made in British Guiana. Tropical rain forest consists of several stories, of which the lowest is the most dense. The data were collected at two contrasting points, one within this lowest story and one in the upper canopy of the forest. The most interesting point related to the humidity of the air. This is continuously high at the lower station, being always very close to saturation point; it is, on the other hand, very variable in the upper canopy. This is of considerable ecological interest as reflecting one aspect of the climate within which the smaller trees of such a forest grow; it is also of importance in connexion with those plantation crops, such as cacao, which naturally occur as under-story trees and so need the type of climate which occurs under the protection of a high canopy.

Dr. A. S. Boughey, finally, discussed "The Effect of Climate on the Distribution of Plant Diseases in the Sudan". Rainfall is the most variable factor, and data were shown to illustrate the types of correlation which have been found to exist between amount of annual precipitation and the incidence of certain important crop diseases. The significance of this correlation is very doubtful with some types of disease, for example, those caused by viruses and rusts; but with those caused by bacteria, smuts and Fungi Imperfecti it is clear and positive. This close correlation between the incidence of disease and rainfall sometimes enables a forecast to be made of the extent to which control measures would be necessary in particular seasons: this is true of bacterial disease

of cotton. Sometimes, also, it largely decides which part of the country a crop shall be grown in; for example, tomatoes remain free from disease if grown in the drier parts of the country.

In the short discussion which followed, it was pointed out that the relationship between animals, and particularly insects, and micro-climates had been entirely neglected, although this forms a most interesting and important part of ecological study. It was thought that in future more attention should be given to this aspect. An interesting reference was made to phenological and climatological work carried out at Bath during the War. This has shown that inversions are a normal occurrence in valleys; during a year at Bath they occurred on each of 130 nights. Flowering dates in Bath are later in the valley than on the hill until about the hundredth day in the phenological year (occurring in May), when the higher day temperatures compensate for the relative lowness of night temperatures in the valley. A plea was made for the concentration of future research on specific problems and for the avoidance of the collection of long records unless these are required to answer such problems. The need for greater rigour in the use of the terms 'micro', 'local' and 'regional', in connexion with climate, was also stressed.

The chairman, in closing the meeting, regretted the absence of reference to animal ecology, but the scope of the subject made some restriction inevitable and the 'sessile' plant demanded first attention. He emphasized the need for the concentration of research on specific problems, and hoped that in the future closer co-operation between meteorologists and ecologists would be possible. W. R. Day

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The following references are of value in connexion with Mr. Manley's and Prof. Brunt's papers:

Manley, G., "Topographical Features and the Climate of Britain", *Geog. J.*, **103**, 241 (1944). "The Effective Rate of Altitudinal Change in Temperate Atlantic Climates", *Geog. Rev.*, **35**, 408 (1945).

Brunt, D., "Some Factors in Micro-Climatology", *Quart. J. Roy. Met. Soc.*, **71**, 1 (1945).

MICROBIOLOGY OF RETTING

RETTING is the process by which the pectic material which binds the fibres to the remainder of the flax stem is broken down and the fibres are liberated. When flax is immersed in water the straw becomes softened and the soluble constituents, which include carbohydrates, glucosides and nitrogen compounds, are extracted. These provide abundant food for growth of the micro-organisms naturally present on the flax plant, and a rapid development of the mixed flora is then accompanied by characteristic chemical changes both in the liquid and in the straw. The retting is effected by certain types of bacteria which break down the pectic complex of the middle lamella of the flax plant, the fibre bundles being first separated from each other and from the cortex and then themselves split lengthwise into fibres.

The quality of the fibre produced and the ease with which it is afterwards spun into yarns and fabrics depend in a large measure on the proper control of this process of retting. Thus the superb quality of Courtrai flax was often attributed to the peculiar properties of the waters of the Lys between Welveghem and Courtrai. Probably, however, it depended much more, as it still depends, on the quality of the Flemish retters, who possess an understanding of flax and its ways acquired through generations of practice in the art.

The work of van Tieghem[1], of Fribes[2], and of Beijerinck and van Delden[3] early indicated that anaerobic spore-forming bacteria (now regarded as strains of *Clostridium butyricum*) were probably responsible for the retting action in ordinary stagnant rets. Carbone and co-workers[4,5,6,7] later claimed that *Clostridium felsineum*, an organism which they isolated from Italian hemp-retting pits, was particularly active in retting and produced fibre of fine quality. Cultures of this organism were added as part of the procedure in the Carbone industrial process for retting flax. Later workers in other Continental countries have noted this organism—recognized by the bright orange colonies which it forms on suitable media—among the flora of anaerobic rets. In the retting process discovered by Rossi and co-workers[8,9,10,11] in Italy, patented by Rossi[12], and established for a time industrially at Bonnétable in France (Carter[13]), a current of air was blown through the contents of the retting tank during the course of the ret. It was claimed that under these conditions aerobic bacteria were the active retting agents, and cultures of *B. comesii*, a facultative spore-forming bacillus, were added at the beginning of retting to hasten and improve the process.

In order to control the end point of retting and to avoid weakening of the fibre through over-retting, various procedures have been introduced to retard bacterial growth in the later stages of retting. These are all based upon the principle that withdrawal of leach liquor, or periodic replacement of part of the retting liquor with fresh water, removes a large proportion of the nutrient material upon which active bacterial growth depends. There are, in fact, a large number of retting processes, wide differences of opinion as to the relative merits of each process, and constant attempts to introduce improvements. This condition reflects the fact that, in the past, retting has been regarded mainly as an art, improvements in the process have been largely empirical, and scientific investigation has been meagre.

Growth of micro-organisms in the retting liquor during an anaerobic ret results in the formation of organic acids, including butyric acid, and at the end of the ret a large volume of a highly polluting and evil-smelling liquor remains for disposal. This problem in disposal has in the past frequently been solved by ignoring its existence, as, for example, in dam-retting in Ireland or in river-retting in Belgium. The growth of popular movements to preserve amenities, and of legislation to restrain those who would despoil them, have, however, assisted the tendency in most countries to replace these comparatively primitive methods by controlled retting in tanks.

These matters were considered at a joint meeting of the Association of Applied Biologists and the Microbiological Panel of the Society of Chemical Industry, held at the London School of Hygiene and Tropical Medicine on April 12, when two papers were read. The first paper was by Mr. T. W. Brandon and Dr. C. B. Taylor on "Recent Developments in the Retting of Flax and Disposal of the Waste Waters"; the second, by Dr. L. A. Allen, dealt with "Recent Developments in the Microbiology of Retting". These authors described investigations carried out during the War by the Water Pollution

Research Laboratory of the Department of Scientific and Industrial Research.

To meet the needs of the Services, a number of new factories were erected at which large quantities of flax were retted. Most of these were so situated that the waste liquor from anaerobic retting could not be discharged untreated without causing serious pollution. Preliminary experiments showed, moreover, that treatment of such liquor would be costly and difficult. The investigation, therefore, aimed at developing a new process of retting in which partial treatment of the liquor would enable it to be re-used in the process. It was found that if the liquor was adequately aerated during retting—for example, by means of a current of diffused air—it could be continually re-used for retting successive batches of flax. Experiments, both on the semi-scale and on the full scale, showed that at least forty batches of flax could thus be satisfactorily retted without any discharge of waste waters. The liquor remaining for disposal at the end of the series was only two or three times as polluting as the liquor from a single anaerobic ret, and was approximately neutral in reaction and comparatively inoffensive in character.

The part played by micro-organisms in the retting process and in the purification of the liquor was assessed from the results of examination of some three hundred samples of liquor and of flax, taken at various stages during the different experimental rets. The flora which developed, both in the liquor and in the flax, during the course of a ret showed the same general characteristics in all the processes investigated. Coliform bacteria consistently formed a high proportion of the total flora and commonly reached numbers of several millions per millilitre of liquor. In some rets *Bacterium coli* type I was the predominant strain—a matter of considerable interest in showing that so-called 'fæcal' coliform bacteria may sometimes develop prolifically in natural conditions outside the animal body. Streptococci of the *Leuconostoc* type, spore-bearing anaerobes, and Gram-negative, biochemically inert rods were also invariably found in large numbers. Aeration of the contents of the retting tank with diffused air encouraged the growth of aerobic and facultative organisms, but it was significant that the number of anaerobes still remained high unless the rate of aeration was excessive.

Bacteria capable of causing soft rot of potato increased considerably in numbers during the course of a ret. Results of a detailed investigation by Allen[14] suggested that organisms with this characteristic were also responsible for the retting action, both types of change being due to a breakdown of the pectic complex of the middle lamella of the plant tissue. In both anaerobic and aerated rets, spore-bearing anaerobes appeared usually to be the active agents in retting, and the majority of strains isolated in pure culture from these rets (which were operated at 30° C.) possessed the characteristics of *Clostridium tertium*. The count of spore-bearing aerobes was usually negligible, but under conditions of excessive aeration *B. subtilis* appeared in large numbers. This organism was found both to rot potato and to ret flax.

Under anaerobic conditions, growth of micro-organisms in the retting liquor resulted in the formation of considerable quantities of organic acids, neutral volatile compounds, and gases. Such liquor could not be used successfully for retting another batch of flax because the accumulation of these metabolic products tended to inhibit further growth of bacteria. Retting action was therefore retarded and eventually stopped. The effect of aeration was to alter the metabolism of the bacteria in the direction of more complete oxidation of the organic matter in the liquor, carbon dioxide and water being formed in place of organic acids and other metabolic products. It was found, in consequence, that in an aerated liquor both the content of organic matter and the polluting strength were reduced by much larger amounts than were usual under quiescent conditions. These findings explained why it was that continuous aeration of retting liquor during the course of a ret enabled the liquor to be re-used for retting subsequent batches of flax, and why it was less acidic and less offensive in character than the liquor from an anaerobic ret.

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[2] Fribes, quoted by Winogradsky, S., *C.R. Acad Sci.*, Paris, **121**, 742 (1895).
[3] Beijerinck, M. W., and van Delden, A., *Arch. néerl. Sci.*, II, **9**, 418 (1904).
[4] Carbone D., and Tombolato, A., *Staz. Sper. Agric. Ital.*, **50**, 261 and 563 (1917).
[5] Carbone, D., and Tombolato, A., *Staz. Sper. Agric. Ital.*, **51**, 355 (1918).
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[7] Carbone, D., and Tobler, F., *Faserforsch.*, **2**, 163 (1922).
[8] Rossi, G., *Staz. Sper. Agric. Ital.*, **35**, 241 (1902).
[9] Rossi, G., *Ann. Scu. Sup. Agric. Portici*, **5** (1904).
[10] Rossi, G., *et al.*, *Ann. Scu. Sup. Agric. Portici*, **7** (1907).
[11] Rossi, G., and Carbone, D., *Ann. Scu. Sup. Agric. Portici*, **9** (1909).
[12] Rossi, G., Brit. Pat. No. 6532 (1908).
[13] Carter, H. A., *Text. Rec.*, **37**, 127, 171, 229, 368, 411 (1919).
[14] Allen, L. A., *Nature*, **153**, 224 (1944).

BICENTENARY OF COLIN MACLAURIN, F.R.S.

ON June 14, two hundred years ago, the famous Scottish mathematician Colin Maclaurin died at York, while a guest of Thomas Herring, then the Archbishop of York, and later Archbishop of Canterbury. Maclaurin's death at the early age of forty-eight was indirectly due to the exposure he had suffered while organising the defences of the City of Edinburgh during the Jacobite rebellion of 1745. At the entry of the rebels into the city, Maclaurin fled to England. In 1733 he had married, and had a family of seven, and from York he wrote that: "Here I live as happily as a man can do, who is ignorant of the state of his family, and who sees the ruin of his country".

Maclaurin was born at Kilmordan, Inverary, in February 1698, being the third son of a minister. Losing both parents at an early age, he was brought up by an uncle and at eleven years of age was sent to the University of Glasgow, where his mathematical talents were soon displayed. At fifteen he took his degree with an essay on gravity. In 1717, when only nineteen, he was chosen professor of mathematics at Marischal College, Aberdeen. Visits to London in 1719 and 1721 made him known to Newton, Dr. Clarke, Martin Folkes and others and he was admitted a fellow of the Royal Society. His academic work was now interrupted by a tour abroad, during which he was tutor to the son of Lord Polwarth, the plenipotentiary of George I. He had already published two works on geometry, and in 1724 he gained a prize from the Paris Academy of Sciences for a memoir on percussion. Returning home, in 1725 he became a candidate for the chair of mathematics at

the University of Edinburgh, then held by the aged James Gregory the second, the brother of David Gregory (1661–1708), once Savilian professor in the University of Oxford, and nephew of James Gregory (1638–75) of telescope fame, both of whom had held the same chair. It was in connexion with Maclaurin's candidature that Newton, then eighty-three years of age, wrote to the Provost of Edinburgh, "I am glad to understand, that Mr. Maclaurin is in good repute amongst you for his skill in mathematics, for I think he deserves it very well. And to satisfy you that I do not flatter him, and also to encourage him to accept the place of assisting Mr. Gregory, in order to succeed him, I am ready, if you please to give me leave, to contribute £20 *per annum* towards a provision for him, till Mr. Gregory's place becomes void, if I live so long, and I will pay it to his Order in London."

In Edinburgh Maclaurin at once made his mark, being both a successful teacher and experimentalist. David Gregory had been the first to teach the Newtonian philosophy in Scotland, and Maclaurin devoted much of his time to the same subject. He was, however, a man of broad interests and practical outlook, and assisted both public bodies and private individuals in many ways. With his colleague Andrew Plummer, who held the chair of medicine and chemistry from 1726, he was very active in the medical society, which about 1739 became the Philosophical Society, the forerunner of the Royal Society of Edinburgh. Maclaurin's "Treatise on Fluxions", published in 1742, was most highly commended by Lagrange and was translated into French by Pezenas in 1749. To-day, however, he is remembered most for his work "An Account of Sir Isaac Newton's Philosophical Discoveries", published two years after his death by his pupil and friend Patrick Murdoch, for the benefit of Maclaurin's widow and children. An elder brother of Maclaurin became known as a preacher and controversialist, while his eldest son, John Maclaurin, rose to the Scottish bench and was created Lord Dreghorn. A sketch of Maclaurin's career was printed by Murdoch in the book on Newton's discoveries. Maclaurin has been referred to as "the one mathematician of first rank trained in Great Britain in the eighteenth century".

A DARWIN LETTER

THE issue of the *Transactions of the Kansas Academy of Science* of December 1945 (vol. 48, No. 3) contains an editorial note and a copy of a letter from Charles Darwin, hitherto unpublished, which it seems probable was the last he wrote before he died. The original of this letter is now in the Library of Kansas University, presented by the son of the late Prof. J. E. Todd (of Iowa), to whom it was written on April 10, 1882, nine days before Charles Darwin's death.

As is pointed out in the editorial comment, Darwin had been suffering from heart attacks some months before, but with the spring he seemed to be rallying, and schemes for further experimental work filled his mind. Prof. Todd's article, which gave rise to the letter, appeared in the *American Naturalist* of April 1882, though it was read before the Biological Society of Washington in March 1881, and must soon have come to the notice of Charles Darwin after publication. The title runs: "On the flowers of Solanum Rostratum and Cassia Chamæcrista", and it deals with the asymmetrical arrangement of the reproductive organs, and in the case of Cassia, of the flower as well.

The detailed observations and the conclusion that such arrangements would encourage cross-fertilization within the species would have delighted Darwin, whose mind had been running on such similar lines. His delight in detailed contrivances and the puzzle of their evolutionary significance was still vividly active in his mind in his seventy-fourth year, and it is fitting that his last known scientific utterance should be on a botanical matter. For there was an evolutionary progression in his own researches. His first insight into science was attained through geology; he moved on to zoology, and thence to botany, with the thread of world evolution connecting each subject. Fifty years before this letter was written he knew practically nothing of botany, and the exigencies of geological and zoological observations and deductions during the voyage of the *Beagle* allowed him scant time to probe any further; yet there is one note on a specimen sent home which shows his discriminating sense of observation, even when backed by little or no knowledge: "The Cactus from Port Desire. The stamens when touched collapsed rapidly and with force on the pistil; as also did the petals, but in a less sudden manner." Movements of stamens; insect visits; fertilization; adaptation and heredity—the germ of interest here lay fallow that led many years later to the publication of six of his books, and to this last known letter written to Prof. J. E. Todd nine days before he died, and here quoted.

April 10 1882

Down,
Beckenham, Kent
Railway Station
Orpington. S.E.R.

Dear Sir

I hope that you will excuse the liberty which as a stranger I take in begging a favor of you. I have read with unusual interest your very interesting paper in the American Naturalist on the structure of the flowers of *Solanum rostratum*, and I shd. be grateful if you would send me some seed in a small box (telling me whether the plant is an annual, so that I may know when to sow the seeds), in order that I may have the pleasure of seeing the flowers and experimenting on them. But if you intend to experiment on them, of course you will not send me the seeds, as I shd. be very unwilling to interfere in any way with your work. I shd. also rather like to look at flowers of *Cassia chamaecrista*.

Many years ago I tried some experiments in a *remotely* analogous case and this year am trying others. I described what I was doing to Dr. Fritz Müller (Blumenau, St. Catharina, Brazil) and he has told me that he believes that in certain plants producing 2 sets of anthers of a different colour, the bees *collect the pollen from one of the sets* ALONE. He wd. therefore be much interested in your paper, if you have a spare copy that you could send him. I think, but my memory now often fails me, that he has published on the subject in Kosmos.

Hoping that you will excuse me, I remain, Dear Sir
Yours faithfully
CH. DARWIN

P.S. In my little book on the Fertilization of Orchids, you will find under *Mormodes ignea*, an account of a flower laterally asymmetrical and what I think that I called right-handed or left-handed flowers.

ROYAL SOCIETY EMPIRE SCIENTIFIC CONFERENCE

H.M. the King, who was accompanied by H.M. the Queen, formally opened the Royal Society Empire Scientific Conference at a ceremony which took place in the Senate House of the University of London on June 17. The King said:

It gives me great pleasure to be here to-day to open the Empire Scientific Conference, and to greet the delegates. It is the first conference of its kind, but I hope it is destined to be the beginning of an era of closer contact in scientific affairs within the Empire. Nothing can take the place of personal contacts. However clearly a man may write, the spoken word has a directness of appeal which cannot be achieved in any other medium.

I am, therefore, very glad to know that you will discuss whether there should be more such meetings as this Conference, and this is a question which, I do not doubt, you will answer in the affirmative. Furthermore, I hope that you will arrange meetings of a more specialized character; and that, whether the meetings be general or related to specific activities, they should not always be held in London, but periodically in one or other of the capital cities of the Empire.

We have recently emerged from a terrible war in which, with God's help, we and our Allies were victorious. For six years, the means of waging war and securing peace have filled our minds and occupied our days. Our energies were concentrated for the most part upon destroying the power of our enemies. Not only had old weapons to be continually improved, but new ones had to be devised, and in this work the scientists played an essential part. But not all the work of scientists had destructive ends in view. Great advances have been made which are of the highest importance to civilization in times of peace. They cover a vast range, and I will mention only one or two of the more important. In penicillin we have a powerful means of fighting disease, the potentialities of which have certainly not yet been fully explored. New insecticides enable us to control and perhaps to defeat the malarial mosquito. We have increased our knowledge of the effects of shock on the nervous system and of the reactions of the human body to rapid changes of temperature and pressure. We have made great strides in the discovery and production of organic chemicals and synthetic drugs. Our necessities have led us to make substantial advances in agriculture and veterinary science. We are also better able to forecast the weather, a development which has been, and must increasingly be, based upon international co-operation. It is, of course, of great importance to the growth of civil aviation. So, too, radar, which has developed for our protection from attack by hostile aircraft, will contribute greatly to the safety of navigation by air and sea. New methods of wireless communication have been evolved, and electronic methods have been adapted to the timing of events which occur so rapidly as to be beyond the scope of any purely mechanical system. Jet propulsion has opened up the possibility of flight at speeds greater than that of sound.

Finally, the production of the atomic bomb through scientific prediction and scientific collaboration has brought home to the world with terrifying directness the fact that the increase in man's knowledge of the material universe may be fraught with infinite possibilities of good and evil. This must never be used as an argument against scientific research. It should rather lead us all to seek for ways and means of increasing our respect for moral principles and to endeavour under God's guidance to reject the evil and choose only the good.

There is good reason to believe that the nearness of the War to the civilian population in their homes and in their daily lives has brought about an awareness of the power of the scientific method, and a realization that what has helped to win the War will also be of service in making the world healthier, happier and more prosperous. We now have to make good the wastage of the last six years and restore our shattered economy, and scientific research must play a great part in reconstruction. It is therefore very gratifying to me to note that my Governments in the United Kingdom and in the Dominions and India have all made provision for increased expenditure upon scientific education and research, in spite of many other calls which they will have to meet. We must see to it that the available resources, both in money and man-power, are efficiently applied.

The Empire is a laboratory richly stored with materials, and it covers a very wide range of terrestrial and climatic conditions. By co-operation in the Commonwealth we can, therefore, develop a greater and wider field of scientific investigation than any other community, always excepting the United Nations Organisation, with which we intend to work to the full. The nations of the British Commonwealth will, I am sure, be ready to play their part.

I now declare the Empire Scientific Conference open, and I pray that God may prosper your deliberations.

Sir Robert Robinson, president of the Royal Society, in welcoming their Majesties, referred to several occasions of historic interest when the Royal Society was brought into close association with Empire affairs, such as the expedition of Captain Cook to observe the transit of Venus, which led to the birth of two Dominions and of many Colonial possessions. He went on to show that the closer relationship with men of science throughout the British Empire engendered by the War had brought a realization of the need for fuller collaboration during peace-time, for the benefit of the Empire and eventually for the improvement of international co-operation. The Royal Society, therefore, with the cordial concurrence of the various Governments of the British Empire, organised the present Conference.

Speaking of the topics to be considered, Sir Robert said:

"Among the more significant are the problems of agricultural science in relation to the varying conditions that obtain in the Empire, and those of medical science, for example, the physiological effects of work in the tropics, and the control of infectious and transmissible diseases. The Conference will consider questions of land utilization and conservation, the survey of mineral resources, and the industries that can arise from the development and proper use of the bountiful material products of the Empire. Provision has been made for the discussion of the important question of the improvement in the dissemination of scientific information, the securing of greater uniformity in standards, and the improvement of co-operation with

existing and projected international scientific organisations. Particular value attaches to measures that may be prepared for increasing the mobility of research workers in the Empire, so that they may be located in the place where their labour can be most fruitful. Much has been done in this direction, but far more remains to be accomplished. . . .

"Science acknowledges only the limitations of man's mind and of human powers of observation, experiment and reasoning; it knows no frontiers of nationality or sect. The first secretaries of the Royal Society were in correspondence with the experimental philosophers in all lands, and the ideal of the widest possible collaboration, set before us by our founders, has ever since been zealously pursued. It is our ambition to make the Empire an example to the world of what may be achieved by friendly intellectual intercourse, the clash of one mind on another, and by mutual criticism and encouragement. . . .

"The discovery of the means of releasing the energy locked in matter is a great triumph of research, and the work of no one man contributed so much to it as that of Lord Rutherford, a great son of the Empire. But the new knowledge can be used for good or for evil, and though the layman must share the responsibility for the choice, the scientists have a special part to play, in the exercise of their consciences, to ensure that their knowledge is used for the noble purpose. I therefore believe that this Conference will be of the utmost value in affording the opportunity for discussion of this topic of such overwhelming importance for the future of the civilized world."

Sir Robert also referred to the conference of scientific representatives of the Governments of the Dominions and India which is to follow the present meetings, expressing the hope that matters discussed during the Royal Society Conference will have been so crystallized that recommendations can be made to the Governments concerned. The tercentenary of the birth of Isaac Newton is being celebrated by the Royal Society during the week beginning July 15; delegates from foreign academies have been invited, and Empire representatives attending the present Conference will be able to attend.

Dr. C. J. Mackenzie, of the Canadian delegation, thanked the King for opening the Conference. "At this time," he said, "perhaps more than at any other moment in history, it is appallingly clear that wars bring nothing but tragedy, suffering and loss to vanquished and victor alike, and that there is little to be found on the credit side; but we can say as Canadians, and I am sure delegates of the other Dominions will echo our words, that out of the splendid scientific co-operation we achieved under the stress of war when the stakes were high, we did learn what are the real essentials of effective co-operation. We learned that effective co-operation is built on respect for the work of others in different fields, we learned that all facets of research, from work of a most fundamental character to the more immediate *ad hoc* applications of scientific techniques, are all important and necessary for a general advance—there is no more a place to-day for scientific isolation within a nation than there is meaning in national isolationism in this international world we live in; and if Empire co-operation and international co-operation in science is to become a reality, we, in our deliberations, must never lose sight of the cardinal principles we learned at such a great price in human sacrifice. . . . This Conference itself, to which many of us have come long distances and at the sacrifice of time we can ill afford, is the best evidence of our quiet determination to arrive at some workable scheme of liaison and exchange of information and personnel that will be of value to the Empire, and will also, we hope, serve as an example for a wider and probably more important international scheme that may be evolved."

NEWS and VIEWS

King's Birthday Honours List

THE following names of men of science and others associated with scientific work appear in the King's Birthday honours list:

Baron: Sir William Beveridge, for public services.

K.C.M.G.: Prof. P. H. Buck, director of the Bernice P. Bishop Museum, Honolulu, and professor of anthropology at Yale University, for services to science and literature.

K.B.E.: Sir William Elderton, lately chief statistical adviser, Ministry of Transport; Dr. J. C. F. Fryer, secretary of the Agricultural Research Council; Prof. J. E. Lennard-Jones, Plummer professor of theoretical chemistry in the University of Cambridge, director-general of scientific research (defence), Ministry of Supply.

Knights: Prof. Cyril Burt, professor of psychology, University College, London; Henry Clay, warden of Nuffield College, for public services; Major-General Gordon Covell, director of the Malaria Institute of India, Delhi; Dr. D. L. Keir, vice-chancellor of the Queen's University, Belfast; Prof. K. S. Krishnan, professor of physics in the University of Allahabad; Mr. Philip R. Morris, vice-chancellor of the University of Bristol, formerly director-general of army education, War Office; Dr. C. C. Paterson, director of the Research Laboratories, General Electric Co., Ltd.; H. L. Saunders, comptroller-general of the Patent Office.

C.M.G.: G. F. March, director of agriculture and forests, Sudan Government; N. A. Middlemas, director of surveys, land officer and commissioner of mines, Uganda; Colonel S. C. Saward, director of surveys, Gold Coast.

C.I.E.: J. F. Russell, chief engineer for irrigation, Bengal; T. M. Coffey, chief conservator of forests, Bengal; H. Crookshank, superintending geologist, Geological Survey of India; Lieut.-Colonel D. R. Crone, superintendent of the Survey of India; H. F. Mooney, chief forest adviser, Eastern States, India.

C.B.E.: Dr. R. B. Bourdillon, director of the Electro-Medical Research Unit (Medical Research Council), Stoke Mandeville Hospital; W. A. Damon, chief inspector of alkali works, Ministry of Health; Prof. P. I. Dee, professor of natural philosophy in the University of Glasgow, lately superintendent of the Telecommunications Research Establishment, Ministry of Aircraft Production; Prof. W. E. Garner,

Leverhulme professor of physical chemistry in the University of Bristol, lately chief superintendent, Armament Research Department, Ministry of Supply; J. McD. R. Greig, director of Moredun Institute, Animal Diseases Research Association; H. Grinsted, director of technical research and development, Ministry of Aircraft Production; C. E. Horton, chief scientist, Admiralty Signal Establishment; Dr. W. B. Lewis, for services as superintendent, Telecommunications Research Establishment, Ministry of Aircraft Production; Prof. R. P. Linstead, director of the Chemical Research Laboratory, Department of Scientific and Industrial Research, for work in the Foreign Office; Dr. A. Parker, director of fuel research, Department of Scientific and Industrial Research; Prof. E. S. Pearson, professor of statistics at University College, London, and associate member of the Ordnance Board; Dr. H. Schofield, principal of Loughborough College; Prof. L. Dudley Stamp, professor of geography in the University of London (London School of Economics and Political Science), chief adviser on rural land utilization, Ministry of Agriculture; Prof. W. N. Thomas, professor of engineering in the University of Wales (University College, Cardiff); Prof. R. Whiddington, Cavendish professor of physics in the University of Leeds, for services to Government Departments.

I.S.O.: R. J. O'Keefe, superintending forestry officer, Department of Natural Resources, Newfoundland.

International Control of Atomic Energy

THE Atomic Energy Commission of the United Nations Organisation met for the first time on June 14. Some idea of the problems and suggestions which the Commission will have under its consideration are dealt with in the leading article in this issue of *Nature* (p. 817); while elsewhere (p. 826), Sir George Thomson discusses the views put forward some time ago at a meeting of the American Philosophical Society, when political, social and moral issues, as well as the more purely physical aspects, were dealt with. Up to the time of writing, the most noteworthy event of the Atomic Energy Commission's meeting had been the presentation by Mr. Bernard Baruch of American proposals for the control of nuclear energy. These were largely based on the report of the Lilienthal Board, the central feature of which is the division of activities in the field of nuclear research into two categories, 'dangerous', as leading to the production of atomic bombs, and 'safe', which includes work concerned with the development of peace-time applications of atomic energy. The suggested Atomic Development Authority, which would conduct research on 'dangerous' developments and provide material for the use of those concerned with academic research and civilian utilization, is accepted by Mr. Baruch, and its significance enhanced by the proposal that its decisions should not be subject to the need for a unanimous vote. The Authority should be the world's leader in all that pertains to atomic knowledge and development. The United States, he said, is prepared to yield to such an international body, step by step as successive stages of control are reached, the present national control of atomic activities which it exerts. In Great Britain, the first annual general meeting of the Atomic Scientists' Association was held on June 15, and at its conclusion it was stated that the Association regards the American proposals with much satisfaction.

Chemistry at Reading: Prof. E. A. Guggenheim, F.R.S.

DR. E. A. GUGGENHEIM, whose appointment to the chair of chemistry at the University of Reading in succession to Prof. H. Bassett has recently been announced, is well known for his contributions to thermodynamics and statistical mechanics and for his original work in the borderland lying between physical chemistry and theoretical physics. After a period of training with R. H. Fowler at Cambridge, Dr. Guggenheim spent some six years at Copenhagen studying reaction kinetics under Brönsted and electrochemistry under Bjerrum; in 1932 he went to California as visiting professor at Stanford University. Returning to England in 1933, he was appointed temporary lecturer at the University of Reading, and two years later, lecturer at University College, London. In 1938 he joined Sir Alfred Egerton at the Imperial College of Science and Technology as lecturer in chemical thermodynamics. During 1939–44 he was engaged almost entirely upon war-work at the Admiralty, first in the Department of Mines and Torpedoes and later in the Department of Miscellaneous Weapons. In 1944 he was transferred to the Anglo-Canadian Atomic Energy Laboratory in Montreal, where he continued until 1946. Dr. Guggenheim, who was elected a fellow of the Royal Society this year, is the author of a large number of papers dealing with various aspects of reaction kinetics, the thermodynamics of mixtures, solutions, electrolytes, super-lattices and surfaces and of the electromotive force of cells with liquid-liquid junctions. He is also author of a standard work on classical thermodynamics, and joint author, with the late R. H. Fowler, of the well-known treatise on "Statistical Thermodynamics".

Exhibition of Gold, Silver and Platinum Products

THE first impression one receives at the exhibition arranged by Messrs. Johnson, Matthey & Co., Ltd., at Dorland Hall, Lower Regent Street, London (June 13–26, admission by ticket from the Company, 73–83 Hatton Garden, London, E.C.1), is the extremely wide range of application of the products of this company and its associates. Besides the production of gold, silver, platinum and similar metals in pure form, there are numerous specialized products, from well-known laboratory ware, thermocouples and chemical plant to electrical contacts, catalysts, electrical measuring instruments, electronic equipment, brazing alloys, ceramic colours and alloys for manufacturing jewellers and dentists, to mention only a few. The less well-known ceramic side of Johnson, Matthey and Co.'s interests is well represented by a display of pottery, china and glassware illustrating the extensive range of brilliant coloured enamels and lustres available, as well as the use of platinum and gold. The jewellery section does not exhibit finished jewellery so much as the special rolled gold wire, gold and silver alloys in various special forms for the manufacturing jeweller, platinum and palladium in jewellery form and special salts and anodes for plating with these metals. The dental, surgical and optical division displays a range of dental gold alloys in wire, castings and inlay form, radium equipment for medical use and a variety of rolled gold shapes for the spectacle manufacturer.

The exhibition also shows the products of Mallory Metallurgical Products, Ltd., one of the associated companies of Johnson, Matthey and Co. These include high-strength, high-conductivity copper alloys

for switchgears and electrical furnaces, beryllium-copper alloys for springs and pressure-responsive elements, spot-welding electrodes, bimetal contacts and circuit breaker contacts. Demonstrations are given of brazing with the various low-temperature silver brazing alloys, 'Easy-flo', 'Argo-flo', 'Sil-fos' and 'Silbralloy', by induction-, resistance-, furnace- and gas-torch heating. The amazing rapidity with which 'Easy-flo' spreads through a joint in a copper assembly has to be seen to be believed. The whole exhibition bears an air of the care and precision with which the products, so often used as standards of measurement, are made.

Scientific Exports (Great Britain), Ltd.

LEADING manufacturers of scientific and surgical equipment in Great Britain have announced the formation of Scientific Exports (Great Britain), Ltd., a new export company. Their plans include group-selling in overseas markets by a wide development of the existing agency organisation of individual members; new agents are also being appointed in territories where member companies had no previous export business. The Company has been formed with the co-operation of the Export Promotion Department of the Board of Trade. The technical knowledge, scientific skill and wide experience of the constituent members will be at the new Company's disposal, and Dominion and foreign customers can therefore bring their requirements and problems to a single source (the Company's overseas agent). The foundation of the new Company has been laid by the following well-known firms: Allen and Hanburys, Ltd.; Baird and Tatlock (London), Ltd.; W. Edwards and Co. (London), Ltd.; Adam Hilger, Ltd.; Hopkin and Williams, Ltd.; W. Watson and Sons, Ltd.; E. R. Watts and Son, Ltd. Between them, these companies offer a wide range of equipment, which includes surgical instruments and sutures, general laboratory equipment, high-vacuum pumps and equipment, spectroscopic and other optical instruments, fine chemicals, microscopes of all types, and surveying instruments. Inquiries should be sent to: Scientific Exports (Great Britain), Ltd., Buckingham House, Buckingham Street, Adelphi, London, W.C.2.

World Economy

A pamphlet "Money and Banking", issued by the Joint Council of Monetary and Economic Research, 20 Buckingham Street, London, W.C 2 (Pp. 36. 1*s.* 6*d.*) as part of a wider study of the functioning of our economic system made by the Engineers' Study Group on Economics, one of the supporting bodies of the Joint Council, attempts to give a picture of the way in which legal tender and bank deposits are produced. After describing the banking system in Great Britain, it discusses the gold standard and outlines briefly the vicissitudes of the economic and financial development of Britain since 1914, down to the introduction of the Bank of England Bill in October 1945. The effect of the Second World War, 1939–45, is dismissed rather summarily, and the absence of any mention of the financial and monetary agreements at Bretton Woods makes the pamphlet necessarily incomplete.

The latter omission is repaired by E. Charles in a rather colourless pamphlet "Freedom from Want: the International Aspect" published by the Royal Institute of International Affairs (Pp. 60. 1*s.* net). Citing first the fifth article of the Atlantic Charter, Mr. Charles outlines the main features of collaboration in a world economy, sketching the structure of a system of international economic collaboration and an approach to the problems with which it must deal. A trend towards a higher degree of central control and planning than existed before the War is recognized, and the view is accepted that the main factors affecting the level of employment are broadly within the control of Government. Any international system proposed must be compatible with the national organisation of full employment policies, and the argument for foreign trade is an argument for efficient production. The choice lies between regionalism based on bilateral bargaining and the reconstruction of a world economy in which international trade would be organised on multilateral lines. Mr. Charles then deals with questions of currency and full employment and outlines the implications of the International Monetary Fund of the Bretton Woods Agreement. The consequences of the Hot Springs Conference on Food and Agriculture and the economic aspects of the work of the Food and Agriculture Organisation are next considered, followed by the questions of commodity controls and the conditions for a constructive policy, foreign trade, and the functions of an international trade commission and international investment. The proposals for an international bank are outlined, and finally Mr. Charles glances briefly at the place and functions of the International Labour Organisation and the limits of collaboration. The pamphlet gives a convenient review of the present position and of the factors to which we must have regard in that gradual development through which alone a satisfactory system of economic collaboration will be achieved.

Amateur Entomologists' Society

THE Amateur Entomologists' Society, which exists to stimulate and broaden the interests of those who take up entomology as a hobby, was founded in 1935. To-day its members number nearly five hundred. Its publications specialize in matters of practical value to the amateur. We have received the two most recent issues of the *Amateur Entomologist*, the Society's principal journal. The annual issue for 1943 is entitled "The Hymenopterist's Handbook", which has been written by a panel of specialists in that order of insects. It contains a good deal of useful information regarding the study and identification of its numerous species. The 1944 issue of that same journal is a similar kind of guide to the study of the Odonata, Heteroptera, mosquitoes and other of the smaller groups of insects. Anyone interested in the work and aims of the Society should communicate with the honorary secretary, Miss Phyllis Rogers, 91 Middle Lane, London, N.8. The membership subscription, it may be added, is only 5*s.* a year.

Books on Medicine, Surgery and the Occult Sciences

A RECENT catalogue (No. 636) issued by Messrs. Bernard Quaritch, Ltd., includes, among other subjects, books on medicine and surgery and on the occult sciences. There are 148 choice items in medicine and surgery, and 319 on the occult sciences. Among the medical books the following are worthy of special mention: there is a copy of "Tractatus de virtutibus herbarum" of Arnold of Vallanova, published at Vicenza in 1491. There is also a superb copy of the "Scriptores Rei Rusticæ", printed in

1482 and bound less than two years later. Vigo's "Chirurgerye", 1543; Lanfranc's "Chirurgerie" (in translation), London, 1565; the first collected edition of "The Works" of John Banister, London, 1633; Gerard's "Herbal", first edition, London, 1597; and Turner's "Herbal", first edition, London, 1551 should be specially noted. Harvey is well represented, among his works being the first English edition of the "De Motu Cordis", 1653, and the first English edition of the "De Generatione", 1653. The section on the occult is not so rich, but there is a fine collection of almanacs. In Catalogue 637, which has just been issued, we note the first Latin edition of Aristotle's "De animalibus", printed at Venice in 1476. We also note a copy of the third edition of Pliny's "Historia naturalis", printed at Venice in 1472.

Awards of the Royal Commission for the Exhibition of 1851

THE Royal Commission for the Exhibition of 1851 announces the award of senior studentships for 1946 to the following: On the recommendation of the University of Cambridge: Mr. G. K. Batchelor (of Melbourne and Cambridge), for research in applied mathematics at Cambridge; Dr. C. J. Eliezer (of Ceylon and Cambridge), for research in theoretical physics at Cambridge; and Mr. C. H. Hassall (of New Zealand and Cambridge), for research in organic chemistry at Cambridge. On the recommendation of the University of Oxford: Dr. R. P. Penrose (Oxford), for research in experimental physics at Oxford.

Lady Tata Memorial Trust Awards

THE trustees of the Lady Tata Memorial Fund announce that, on the recommendation of the Scientific Advisory Committee, they have agreed, if circumstances permit, to make the following awards for research in blood diseases, with special reference to leukæmia, in the academic year beginning on October 1: *Grants for expenses and assistance:* Dr. Jørgen Bichel (Denmark), for work at Aarhus, Denmark, and in the United States; Dr. Pierre Cazal (France), for work at Montpellier; Dr. Peter A. Gorer (Great Britain), for work in London; Dr. Maurice Guérin (France), for work in Paris; Dr. Werner Jacobson (Great Britain), for work at Cambridge; Dr. Edith Paterson (Great Britain), for work at Manchester; Prof. Edoardo Storti (Italy), for work at Pavia. *Scholarships (whole-time or part-time):* Dr. Jal J. Dubash (India, at present in the United States), for work in New York; Dr. Pierre Dustin (Belgium, at present in Great Britain), for work in London and Brussels; Dr. Simon Iversen (Denmark), for work in Copenhagen; Dr. Joseph Japa (Poland, at present in Great Britain), for part-time work at Edinburgh; Dr. Hall Schartum-Hansen (Norway), for work probably at Manchester.

University of London

DR. GWYN WILLIAMS, since 1939 lecturer in chemistry at King's College, London, has been appointed to the University of London chair of chemistry tenable at the Royal Holloway College as from October 1. The title of reader in economics in the University of London has been conferred on Mr. Nicholas Kaldor in respect of the post held by him at the London School of Economics.

The Senate has decided to confer the honorary degree of doctor of science on the following: Prof. E. D. Adrian, professor of physiology in the University of Cambridge; Dr. James B. Conant, president of Harvard University; Sir Henry Dale, past-president of the Royal Society; Prof. R. A. Fisher, Arthur Balfour professor of genetics in the University of Cambridge; Sir Geoffrey Taylor, Yarrow research professor of the Royal Society; Prof. C. T. R. Wilson, emeritus professor of natural philosophy in the University of Cambridge; shortly before his death Lord Keynes had accepted the offer of the honorary degree of doctor of science (economics).

X-Ray Analysis during the War Years

THE X-ray Analysis Group of the Institute of Physics is to hold its annual conference during July 9–11 at the Royal Institution, Albemarle Street, London. Some sixty scientific workers from overseas are attending the meeting, which is to consist mainly of accounts of work carried out during the war years on X-ray analysis. Sir Lawrence Bragg is to take the chair at each session and will deliver an evening lecture on "Metals" at 8 p.m. on July 9. At the morning session of that day, R. W. G. Wyckoff is to give a review of developments in electron microscopy in America during the last six years, to be followed by an account of thermal and other perturbations of crystal structures by K. Lonsdale. In the afternoon, J. Wyart will review the X-ray work carried out at the Sorbonne during the occupation, and W. H. Zachariasen will give an account of the crystal chemistry of rare-earth elements and of thorium, uranium, neptunium, plutonium. On the following day, J. M. Bijvoet will review X-ray researches in Holland, including accounts of crystal structures, application of new methods, lattice distortion and studies on recrystallization. English work on organic structures, including penicillin and hæmoglobin, is then to be reviewed by J. D. Bernal. The afternoon session will include, it is hoped, a review of X-ray work in the U.S.S.R. by a prominent Russian man of science, to be followed by an account of electron microradiography by J. J. Trillat and researches on the applications of radiocrystallography by A. Guinier. The third day of the conference will open with accounts of the crystallography of metals by D. Harker and of electron diffraction by L. O. Brockway. W. T. Astbury will follow with a review, "X-rays and Biology", dealing with the complex macromolecules of the proteins, polysaccharides and nucleic acids. The conference is to conclude with a review of Swiss work by P. Scherrer and of work in Sweden by I. Waller. Each morning and afternoon session is planned to give time for discussion. During the proceedings, Sir K. S. Krishnan will talk on the "Diffuse Scattering of Electrons in Metals and Alloys in relation to their Resistivities" and R. C. Evans will give an account of X-ray crystallography in Germany. The conference will be open to all interested without charge, and application to attend should be made as soon as possible to the honorary secretary, Mr. F. A. Bannister, British Museum (Natural History), Cromwell Road, London, S.W.7, or direct to Dr. H. R. Lang, Institute of Physics, 19 Albemarle Street, London, W.1.

ERRATUM. In the communication entitled "A Light Reaction with Negative Temperature Coefficient" in *Nature* of March 23, p. 373, the velocity equation quoted should read: $v = k I_0(1-e^{-ict})$, where I_0 is the intensity of the incident light.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Observations on the Administration of BAL-Intrav to Man

In their original communication about BAL-Intrav, Danielli, Danielli, Mitchell, Owen and Shaw[1] referred to some of the work on man which we had at that time begun. Since we have been forced to abandon this work for the time being, owing to the desirability of studying some of the nutritional problems in Germany, we have decided to publish our preliminary observations for the benefit of those who may be interested in the subject.

The BAL-Intrav was made up as a 25 per cent solution and sterilized by passing the solution through a Seitz filter. Commencing with a few milligrams, the dose was gradually increased to 1 gm. and afterwards to 2 gm. and 4 gm. Five men and one woman acted as the experimental subjects, and all the doses were given intravenously. There were no unpleasant symptoms or reactions, and since, after precautionary intradermal tests, several people received a second dose some weeks after the first, it is concluded that BAL-Intrav is essentially non-toxic for man, as it is for animals, and that it has no allergic properties. Very soon after its administration has begun some volatile component begins to be excreted through the lungs, and the subject can detect it by its smell. After doses of 1 gm. and more, the urine also has a distinct smell.

Since the value of BAL-Intrav as a chemotherapeutic agent depends upon its formation of a soluble compound with arsenic, we wondered to what extent it might also form soluble compounds with the heavy metals normally present in serum—iron, copper and zinc—and thereby increase their excretion in the urine. Urine was accordingly collected from the six subjects before and after administration of the BAL-Intrav and analysed for these metals. The drug increased the excretion of copper about twenty times, and that of zinc about five times, but it did not consistently raise the output of iron. The details of these experiments are given in the table.

Subject	Intravenous dose	Urinary excretion (μgm. per hr.)					
		Iron		Copper		Zinc	
		Before	After	Before	After	Before	After
R.M.	2 gm. BAL-Intrav			3·6	65·8	39	178
E.W.	2 gm. BAL-Intrav			4·6	126·0	65	93
A.W.	4 gm. BAL-Intrav	36·6	67·3	6·5	235·0	58	585
G.S.	4 gm. BAL-Intrav	41·2	39·7	14·0	142·0	84	295
G.W.	4 gm. BAL-Intrav	51·0	53·2	9·7	206·0	111	527
K.B.	4 gm. BAL-Intrav	42·9	43·2	5·7	153·0	60	400

The BAL-Intrav itself contained small amounts of copper and zinc; but it is impossible to make an accurate correction for this because of the uncertainty of knowing how much BAL-Intrav was excreted in the urine during the time of observation. Even if the whole of the copper and zinc introduced with the BAL had left the body during the first hour, the correction to be applied would only be a minor one and would not materially alter the conclusions.

R. A. McCance
E. M. Widdowson

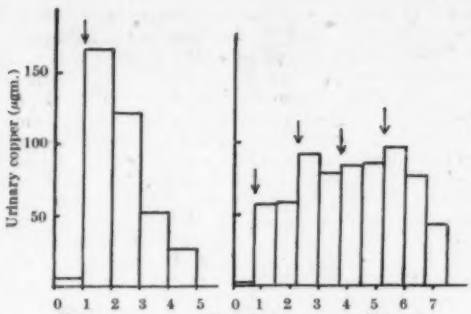
Department of Experimental Medicine,
Cambridge.
May 18.

[1] Danielli, J. F., Danielli, M., Mitchell, P. D., Owen, L. N., and Shaw, G., *Nature*, **157**, 217 (1946).

Effect of BAL-Intrav on Excretion of Copper by the Sheep

McCance and Widdowson[1] have shown that intravenous injection of BAL-Intrav (dithioglycerol glucoside) increased greatly the urinary excretion of copper in man. In view of the importance of naturally occurring diseases in sheep associated with either a deficiency of copper (for example, enzootic ataxia[2] or 'swayback' of lambs) or an excessive storage of copper (for example, toxæmic jaundice[3]), preliminary trials were made to ascertain whether, in sheep, BAL-Intrav would similarly influence the excretion of copper. It was felt that the experimental use of this substance and of related compounds might prove of value in the elucidation of some of the unsolved problems associated with the copper metabolism of the sheep.

Under suitable restraint, the bladder was emptied by catheter and washed by injection of warm, sterile saline solution. After a control period, the urine was collected and the solution of BAL-Intrav was injected intramuscularly. At regular periods thereafter the urine was collected. Precautions were taken to avoid contamination of the urine by copper. Analyses for copper were performed, after digestion with sulphuric, perchloric and nitric acids, by the development of the copper compound with diethyldithiocarbamate using the modification of Clare *et al.*[4] Corrections were made for the copper present in the BAL-Intrav solution.



GRAPHS SHOWING EFFECT ON URINARY EXCRETION OF COPPER FOLLOWING INTRAMUSCULAR INJECTION (AT THE TIMES INDICATED BY THE ARROWS) OF (*A*) A SINGLE DOSE OF 4 GM. BAL-INTRAV; (*B*) 4 DOSES, EACH OF 1 GM., OF BAL-INTRAV

The data presented graphically show that the rate of excretion of copper was increased to some thirty times the normal value. With the larger dose, excretion reached a maximum during the first hour after injection and fell rapidly during succeeding hours; with the smaller, repeated doses, high levels of excretion were maintained. BAL-Intrav produced no apparent deleterious effects and was rapidly excreted in the urine. Data for the toxic dose of BAL-Intrav in the sheep are not available, but it is probable that the doses used (namely, 0·1 gm./kgm. and 0·04 gm./kgm.) are far below the toxic dose; for the rat the lethal dose (L.D. 50) is about 7·5 gm./kgm.[5].

Although the actual amount of excess copper excreted in these two cases was quite small (approximately 300 μgm. and 600 μgm., during the periods measured), the excretion could probably be greatly increased by the use of larger doses, frequent or continuous injections, or possibly by the concurrent use of BAL (dithioglycerol) with BAL-Intrav.

Ian W. McDonald

School of Biochemistry,
Cambridge.
May 18.

[1] McCance, R. A., and Widdowson, E. M., see preceding communication.
[2] Bennetts, H. W., and Beck, A. B., Coun. Sci. Ind. Res. (Aust.), Bull. 147 (1942).
[3] Albiston, H. E., Bull, L. B., Dick, A. T., and Keast, J. C., *Aust. Vet. J.*, **16**, 233 (1940).
[4] Clare, N. T., Cunningham, I. J., and Perrin, D. D., *N.Z. J. Sci. Tech.*, **26**, 340 (1945).
[5] Danielli, J. F., Danielli, M., Mitchell, P. D., Owen, L. N., and Shaw, G., *Nature*, **157**, 217 (1946).

Inactivation of Thrombin

Barratt[1] found in 1932 that bacteria do not cause the decomposition of thrombin preparations, but rather that this is a chemical process. I have shown that the inactivation of thrombin in native blood and in the pure thrombin solution is the same process as that which is caused by an inactivating system in plasma, but which in the preparation is present as an impurity.

The inactivation effect of blood is relatively high. 1 ml. of native blood mixed with 100 units of thrombin causes about 99 per cent inactivation in 10 minutes. (1 unit is the quantity of thrombin which clots 1 ml. of blood in 1 minute at 20° C.) This inactivator could destroy a much greater quantity of thrombin equally well.

The inactivation of thrombin ('transformation to metathrombin') is considered by some investigators as adsorption[2], by others as the effect of a dialysable substance[3]. I have demonstrated on the basis of reaction-kinetic experiments that neither of these views can be accepted; inactivation is due to two parallel and separate causes, namely, a sudden adsorption, and a fermentative inactivating process (Fig. 1).

Thrombin adsorption is reversible. At a low concentration it follows the Langmuir adsorption isotherm; but at a high concentration it shows deviations from this law. Increase of temperature diminishes the adsorption, and the presence of chloroform or alcohols hinders it. In plasma heated to 100° C. (and again cooled) adsorption takes place.

Thrombin inactivation due to the effect of ferments follows a monomolecular reaction type (k, 0·4–0·5 at 20° C.). Increase of temperature increases the power of the inactivator. If we increase the temperature by 10° C. the value of k is increased 2–2·5 times. At higher temperatures (58–60° C.) the inactivator ceases to function. Metals (Al^{+++}, Fe^{+++}) accelerate, metal-binding reagents hinder, the effect of the inactivator. After dialysis the inactivating capacity of the plasma diminishes without the dialysing water showing the effect of inactivation. If, however, we added the dialysing water to the dialysed plasma again, the plasma regains its original capacity for inactivation. The observed phenomena show that the inactivator has the characteristics of a ferment.

During clotting (due to the effects of inactivation) 1 ml. of blood contains only 4–5 thrombin units; on eliminating the inactivator I found that 1 ml. of blood contained 300 units of thrombin (Fig. 2).

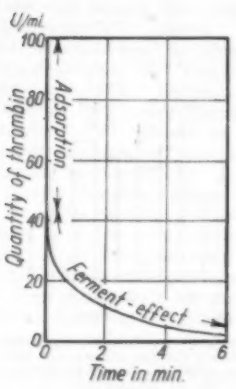


Fig. 1

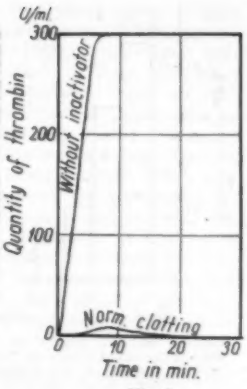


Fig. 2

In blood conserved for blood transfusions, the inactivator is almost completely lacking: thus it resembles thrombose-blood. This last observation agrees well with the data of Lenggenhager[6]. The inactivating capacity of thrombose-blood was shown in a 10-minute test. The durability of the thrombin preparations is in reverse proportion to the quantity of inactivator impurity.

Full details of this work will appear in the *Acta Physiologica Hungarica*.

M. GERENDAS

Biochemical Laboratory,
Hungarian Biological Research Institute,
Tihany.
April 30.

[1] Barratt, J. O. W., *J. Physiol.*, **75**, 428 (1932).
[2] Landsberg, M., *Biochem. Z.*, **50**, 245 (1913). Quick, A. I., *Amer. J. Physiol.*, **123**, 712 (1938). Wöhlisch, E., and Grüning, W., *Biochem. Z.*, **305**, 183 (1940).
[3] Moravitz, P., *Bei. chem. Physiol. u. Path.*, **4**, 381 (1904). Pekelharing, C. A., *Hoppe-Seylers Z.*, **85**, 341 (1913). Lenggenhager, K., *Helv. med. Acta*, **1**, 527 (1935).
[4] Lenggenhager, K., "Über die Entstehung, Erkennung und Vermeidung der postoperativen Fernthrombose" (Verl. Georg Thime, Leipzig, 1941).

Inactivation of Antibacterial Substances with Cysteine

A WIDE range of therapeutic substances (for example, arsphenamine[1], 2-methyl-1 : 4-naphthaquinone[2], penicillin and other mould products[3,4] and tervalent antimonials[5]) is inactivated by cysteine. Colwell and McCall[2] found that cysteine antagonizes the antibacterial action of 2-methyl, 2-methyl-3-chloro- and 2 : 6-dimethyl-1 : 4-naphthaquinone on *B. coli*, but not that of 2-methyl-3-methoxy-1 : 4-naphthaquinone, and postulated that inactivation might be caused by reaction of the sulphydryl group from the cysteine at the 3-position of the quinone. Geiger and Conn[6] have suggested a somewhat similar mechanism for the inactivation of patulin and penicillic acid.

We considered that a polarographic investigation of the reaction with cysteine might provide additional information about the character of the reaction. Cysteine and cystine in an ammoniacal cobalt buffer solution yield a catalytic polarographic step, which disappears if the sulphydryl group enters into chemical combination[7]. By measuring the rate at which the height of the catalytic step decreases, the velocity of the reaction can be determined. The technique does not give information about the oxidation of cysteine to cystine, but this information can be obtained by combining the polarographic method with the sodium nitroprusside test.

The following technique was used to study the reaction between cysteine and a number of representative quinones and mould products: 1 ml. of 0·02 *M* cysteine hydrochloride was mixed with 1 ml. of a 0·02 *M* solution of the therapeutic substance and 4 ml. of a phosphate-citrate buffer solution (pH 7·0); the mixture was diluted to 20 ml. with air-free water and stored at room temperature in a rubber-capped bottle. A 1-ml. sample was withdrawn immediately by means of a graduated syringe and diluted to 10 ml. with air-free water. 1 ml. of the dilution was added to 10 ml. of a freshly prepared ammoniacal cobalt buffer solution (0·002 *M* cobalt chloride, 0·2 *M* ammonium hydroxide, 0·2 *M* ammonium chloride, and 0·02 per cent gelatin) and made up to 20 ml. with water, and a portion of it was examined in the polarograph. Further 1-ml. samples were withdrawn after 3 and 24 hours and tested in the same way. The experiment was repeated using an excess of the drug. The quinones were examined in 25 per cent aqueous dioxane solution. Each experiment was paralleled by a control experiment in which the drug was omitted.

When one gram-molecule of any of the drugs was used for every gram-molecule of cysteine, there was little effect on the catalytic step. Nevertheless a ten-fold excess of quinones, unsubstituted in the 3-position, and either substituted or unsubstituted in the 2-position (for example, benzoquinone, 1 : 4-naphthaquinone and 2-methyl-1 : 4-naphthaquinone), suppressed the step, indicating that a reaction had taken place. The reaction was not quantitative; but probably a portion of the cysteine had been oxidized to cystine, for the final solutions failed to give a mauve colour with sodium nitroprusside. Quinones substituted in both the 2- and the 3-positions (for example, phthiocol and phthiocol methyl ether) did not react with cysteine. Of the mould products tested, patulin (clavacin or claviformin) reacted more readily than crystalline sodium penicillin II (penicillin *G*); citrinin was least reactive.

It is thought that these preliminary results are of some interest, and that further development of the polarographic technique might provide important information about the mechanism of drug action.

J. E. PAGE
J. G. WALLER

Glaxo Laboratories, Ltd.,
Greenford, Middlesex.
May 14.

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Chondrodystrophy (Achondroplasia) and Humoral Agents

IN *Nature*[1] and elsewhere[2,3], A. N. Studitsky has recently made statements to the effect that "studies of the interrelationship of the endocrine glands in the causation of experimental chondrodystrophy, taking into account the influence of the vitamin D balance, prove almost certainly the hypothesis of the humoral nature of this disease". More specifically it may, according to Studitsky, be concluded "that the achondroplasia of the chick embryo is a hyperparathyroid dystrophy of the skeleton, developing against the background of avitaminosis D", and the author continues that "it does not seem improbable that our hypothesis as to the nature of fetal achondroplasia can also be extended to the analogous affection in man". It is the purpose of this note to point out very briefly that one of the few conclusions which available evidence permits one to draw concerning the causation of chondrodystrophy is that humoral agencies play no part in the origin of this skeletal abnormality.

The statements of Studitsky are based on two lines of evidence, namely, observations on chorio-allantoic transplants of bones from heterozygous Creeper fowl embryos and skeletal reactions of normal chicken embryos bearing chorio-allantoic pituitary transplants.

I have shown[4] that the skeletal peculiarities of Creeper fowl consist in a chondrodystrophy-like condition. Studitsky reports that tibiæ of 7½- and 8-day Creeper embryos transplanted to the chorio-allantois of normal hosts take an entirely normal course in regard to cartilage differentiation, bone formation, and other features. He arrives at the conclusion[2] that: "Les difformités du squelette creeper ne sont pas encore déterminée aux stades précoces du développement. Elles apparaissent à la suite d'un retard du développement des tissus osseux et cartilagineux, provenant sans doute des conditions humorales qui se sont formées dans l'embryon creeper en croissance".

There is little reason to doubt that the heterozygous and homozygous expressions of the Creeper mutation reflect quantitatively differing effects of the *same* fundamental aberration from normal development. Since homozygous Creeper embryos generally die at the end of the third day of incubation, that is, prior to the appearance of any glandular tissues, endocrine factors are excluded as a possible primary cause. It is for this reason that a study of the endocrine glands of Creeper fowl seemed pointless. Moreover, there is ample experimental evidence for the conclusion that the homozygous as well as the heterozygous features of Creeper fowl extremities are fully determined long before endocrine factors can play any part, and for the further conclusion that these features remain uninfluenced by the humoral environment of normal hosts. Experiments by Hamburger[5], with a technique incomparably superior to that of chorio-allantoic transplantation, have shown that the heterozygous and homozygous peculiarities of Creeper limbs are fixed "at least as early as the fifty-fourth hour of incubation and cannot be reversed by implantation into a genetically normal host". Rudnick[6] arrived at essentially the same conclusion in grafts from 6–19 somite stages of heterozygous and homozygous Creeper embryos, that is, stages prior to the establishment of embryonic circulation. It can, therefore, be stated with assurance that humoral factors have no part in determining the chondrodystrophic features of the extremities of Creeper fowl.

In an attempt to analyse the origin of sporadic (that is, non-hereditary) chondrodystrophy of developing chicks Studitsky transplanted fragments of pituitary gland on to the chorio-allantoic membrane of normal seven- and eight-day embryos. He reports that he obtained by this method a significant excess in incidence of sporadic chondrodystrophy, as compared with unoperated controls, and he interprets his observations as due to pituitary stimulation of the host's parathyroid glands, in the presence of a vitamin D deficiency and a resulting interference with normal skeletal development.

It cannot be determined from the description of Studitsky's material whether or not the abnormal embryos which he found show the histological criteria of chondrodystrophy. The fact that he makes reference in this connexion to a micromelia of nutritional origin, described by me[7], without mentioning that this micromelia (afterwards found to be due to manganese deficiency) was reported as being "quite distinct" from sporadic chondrodystrophy, does not inspire confidence. It should be noted also that Pighini[8], after even earlier pituitary transplants, did not obtain results comparable to those of Studitsky. However, even if it were granted that the experimental conditions to which Studitsky subjected his embryos led to an appreciable incidence of micromelia, and if it were granted further that this micromelia bears resemblance to chondrodystrophy, for which there is no

certain evidence, it must be contended that there is no justification for the conclusion that sporadic chondrodystrophy of chicken embryos, let alone the corresponding abnormality in man, is due to or in any way affected by disturbances of an endocrine nature. One argument against such a conclusion is the fact that sporadic chondrodystrophy of chicken embryos can already be observed at the very stages at which Studitsky made his pituitary implants. It must be questioned also if evidence, such as has been presented by Studitsky, ever justifies the inference that the natural course of events has been duplicated. In experiments which will be described elsewhere I have found that a very high incidence of micromelia can be induced in chicken embryos by injecting, as early as the beginning of the fourth day of development, two units of insulin into the yolk of eggs. It would be absurd to interpret these results as indicating the involvement of the pancreas or any other endocrine gland in the causation of micromelia. Studitsky's experiments may demonstrate that disproportionate skeletal growth can be imposed at relatively late stages of development, but they certainly do not prove anything about the causal origin of sporadic chondrodystrophy.

WALTER LANDAUER

Storrs Agricultural Experiment Station,
University of Connecticut,
Storrs, Connecticut.
May 15.

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Hydrated Cellulose from Jute Fibre

IT is well known that the change in the structure of cellulose in ramie produced by the action of caustic soda solution and by subsequent treatment with water depends largely on the concentration of the alkali used, the temperature and the magnitude of tension to which the fibre is subjected during the treatment. Hess and Trogus[1] showed that if unstretched ramie is treated with 12·5–18 per cent sodium hydroxide solution and afterwards washed with water, the product gives the X-ray pattern of hydrated cellulose. Sakurada and Hutino[2] later pointed out that unstretched ramie treated with 16 per cent sodium hydroxide solution and washed with water for five minutes gives in the moist state a structure different from that of hydrated cellulose, and this product in the moist state was designated as "water cellulose" by them. On being dried at 24° C. for three days in free air, water cellulose is converted to hydrated cellulose.

In the course of our work under the scheme on the X-ray analysis of jute fibre financed by the Indian Central Jute Committee, it has been observed that unstretched raw jute fibre first treated with 30 per cent sodium hydroxide solution for half an hour, then washed with water at about 35° C. for ten minutes and dried in free air at room temperature for three days, gives a diffraction pattern which is different from that due either to water cellulose or to ordinary hydrated cellulose. The spacings of the planes giving intense reflexions in the equatorial line and the dimensions of the unit cell of this new hydrated cellulose obtained from raw jute fibre are given in the accompanying table along with those for water cellulose and ordinary hydrated cellulose.

	Water cellulose	Ordinary hydrated cellulose	Hydrated cellulose from jute
A_1	8·98 A.	7·32 A.	7·96 A.
A_2	4·41 "	4·45 "	4·42 "
A_3	3·95 "	4·03 "	4·03 "
a	10·03 "	8·14 "	8·8 "
b	10·3 "	10·30 "	10·3 "
c	9·98 "	9·14 "	9·5 "
β	52° "	62° "	57° 54'

The pattern obtained shows sharp but elongated reflexions indicating the increase in the size of the micelles but deterioration of their orientation along the fibre axis. The physical properties of this hydrated cellulose appear to be similar to those of coarse wool and superior to those of hydrated cellulose obtained from jute fibre with 12 per cent caustic soda. The stability of its structure under different physical conditions is being investigated.

We are indebted to Prof. M. N. Saha for his interest in the work and to the Indian Central Jute Committee for the financial help.

S. C. SIRKAR
N. N. SAHA

Palit Laboratory,
Physics Department,
University of Calcutta.
May 10.

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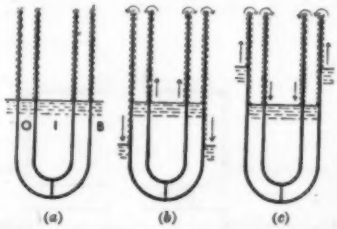
[2] *Koll. Z.*, **77**, 346 (1936).

Zero Point Diffusion in Liquid Helium II

THE fundamental analogy between superconductivity and the λ-phenomenon of liquid helium to which we directed attention a few years ago[1] is based on the observation of frictionless transport and on the fact that the superconductive electrons as well as the superfluid helium atoms have zero thermal energy even at finite temperatures[2]. In view of this fact, it has been suggested by one of us[3] that the momentum of frictionless transport may be derived from zero point energy and that this transport may even take place in the absence of an external accelerating potential. Indeed this process seems to fit the case of a superconductor in which a flow of electrons occurs under zero electromotive force. On the other hand, it has generally been assumed up to now that in the frictionless transfer of helium II along a surface film[4] helium atoms are accelerated by the gravitational potential; an explanation which has for some time appeared doubtful to us[5].



TRANSFER OF LIQUID HELIUM II UNDER ZERO GRAVITATIONAL POTENTIAL. (*a*) STATE OF EQUILIBRIUM, (*b*) BEAKER EMPTYING AND (*c*) BEAKER FILLING. THE ARROWS INDICATE THE DIRECTION OF FILM TRANSFER

We have now carried out an experiment which demonstrates that this transfer takes place even *without* gravitational acceleration. A beaker consisting of two concentric vessels was suspended in a bath of liquid helium II. Then the state of equilibrium is the one in which the levels in the inner vessel (I), the outer vessel (O) and the bath (B) are all at equal height. When the beaker is lifted to a higher position, (I) and (O) are emptied by surface transfer over the rims of the vessels into (B). This took place at the expected rate but *without a separation of the levels in* (I) and (O). Thus, while helium is transferred from (O) to (B) under a potentia drop, the transfer between (I) and (O) takes place under zero potentia difference. From earlier determinations of the film thickness[4] and from the observed rate of transfer as well as from considerations arising out of the dimensions of the beaker, the minimum average velocity of the helium atoms flowing from (I) into (O) could be calculated to be about 18 cm./sec. This means that a difference of level of at least 1·6 mm. between (I) and (O) would have been necessary in order to produce this velocity by gravitational acceleration. Our observations, which were facilitated by a slight constant separation of the levels in (I) and (O) due to surface tension, showed that no change in the relative position of the levels greater than $\pm$ 0·1 mm. (our limit of accuracy) took place. The levels in (I) and (O) also stayed together when the flow was reversed by setting the bath level above that in (I) and (O). Finally, when the level in (I) was raised above that in (O) by filling it from the bath, it afterwards adjusted itself again to equal height with the level in (O).

Our experimental arrangement is a close analogue to an electric circuit containing a superconductor. In such a circuit the current has to be limited by a resistance so as not to exceed the threshold value. Only if this condition is fulfilled will a super-current under zero electrical potential be established. In the beaker the place of this resistance is taken by the diameter of the outer vessel, which limits the rate of helium transfer in the whole arrangement and thereby permits a flow from (I) to (O) without gravitational acceleration. A more thorough discussion of the experiment has to be left to a detailed publication. However, the result seems to leave no doubt that it is not the gravitational field of force which causes the frictionless transfer of liquid helium II. Seen in conjunction with the fact that the superfluid helium atoms have zero thermal energy, the result appears to strengthen our supposition that the phenomena of frictionless transport are direct manifestations of a diffusion of superfluid particles under zero point momentum[3]. Experiments are in preparation for the observation of other effects predicted on this basis[3], the most striking of which would be isothermal heat conduction and a persistent mass flow in liquid helium II.

Since the liquefaction plant in Oxford is not yet in operation, the experiment was carried out at the Royal Society Mond Laboratory in Cambridge. We are grateful to Dr. J. F. Allen not only for granting us facilities for this work but also for his kind help in preparing and carrying out the experiment.

J. G. DAUNT
K. MENDELSSOHN

Clarendon Laboratory,
Oxford. May 14.

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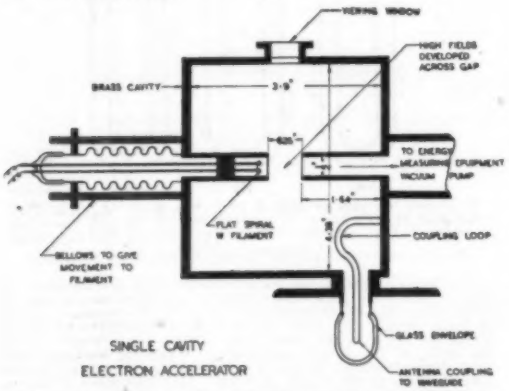
Application of Pulse Technique to the Acceleration of Elementary Particles

THE acceleration of elementary particles with the aid of radio frequencies has been known for a considerable time. Sloan and Lawrence[1] accelerated mercury ions to an energy of 1·2 MeV. in their linear accelerator using radio frequencies of 10 Mc./s. Later Sloan, using a single resonant circuit at 6 Mc./s., accelerated electrons to 800 kV. and thereby laid the foundation of an industrial X-ray equipment.

These two devices suffer in some ways because of the relatively low radio frequencies involved, and to overcome them the course of development has tended towards cyclic devices of which the betatron and cyclotron are typical. As a result of development during the War, techniques are now available, however, which can be applied to the linear accelerator with advantage. These are the generation of high peak pulse-power, the use of very high frequencies and the use of resonant cavities which eliminate problems of insulation. The possibility of overcoming some of the difficulties of the older methods with the aid of these techniques has led us to investigate them further with interesting results.



SINGLE CAVITY ELECTRON ACCELERATOR

A cavity was made up in the form shown diagrammatically and fed with pulses of 5 microsec. duration. The radio frequency was 1,200 Mc./s. and the pulse repetition rate 200 per sec. With the cavity absorbing a peak power of 150 kW., we have found that electrons with energy of 600 kV. are easily obtainable, the mean current during the pulse being 50 milliamp. The energy spectrum is surprisingly narrow, being about 50 kV. to half current. These results are sufficiently encouraging for us to proceed with the acceleration of electrons to considerably higher energy-levels by multiple acceleration. Efforts are also being made to accelerate protons in the same way, and there are hopes of finally obtaining both electrons and protons of energy up to 5–10 MeV. This will not compete with some other accelerators, but the method is attractive because it might lead to a simple, cheap and compact research tool for studies in nuclear physics.

E. G. BOWEN
O. O. PULLEY
J. S. GOODEN

Council for Scientific and Industrial Research,
Radiophysics Laboratory,
University Grounds, Chippendale, N.S.W.
Feb. 7.

[1] *Phys. Rev.*, **38**, 2021 (1931).

Possibility of Emission of a Very Hard Radiation from the Solar Corona

THE result of the recent identification of coronal lines (by Edlén) and the very high electron temperature found in the inner part of the solar corona should be the presence of a very hard and intense monochromatic radiation in the spectrum of the latter. According to Edlén, the resonance potential of iron ions emitting coronal lines is about 35 V. If the electron temperature of the corona is 350,000° (as assumed by Grotrian) the mean kinetic energy of the coronal electrons will be about 35 V. Therefore, every inelastic collision of an electron with a coronal iron ion may bring about the excitation of the resonance-level of the latter. One can prove that in the corona the average frequency of excitation of levels with a potential of excitation between 35 and 70 V. by an electron collision will be of the same order as the frequencies of excitation of the sub-levels of the ground configuration. These sub-levels are the initial levels for the radiation of coronal lines.

In the corona, the intensity of emitted lines is proportional to the number of excitations of the initial level and to the emitted frequency, therefore the intensity of hard coronal radiation should not be less than the intensity of the observed coronal lines. The following may be considered as proofs of the emission of hard radiation by the corona. According to Edlén, the coronal line λ 7059 A. (Fe XV) is emitted during the transition between sub-levels of the second quantum state of this ion. The ground-state of this ion is the single level $3s^2S_0$. The following (second) state is the triplet $3s3p\,{}^3P_{2,1,0}$. The sub-levels P_0 and P_2 are metastable, P_1 is not. During the transition $P_2 - P_1$ the line λ 7059 A. is emitted. But if it is in state P_1, the ion Fe XV will be transmitted to the ground-state S_0 and the line λ 424 A. emitted. That such is the value of λ may be concluded from the table of terms Fe XV, experimentally derived by Edlén[1].

The intensity of λ 424 A. is at least $\frac{7059}{424} \simeq 17$ times more than the intensity of λ 7059 A., or about one third of that of the most intense coronal line λ 5303 A.

Assuming that the intensity of hard coronal radiation is equal to the intensity of the observed monochromatic radiation of the corona, then the ratio between the intensity of the hard radiation of the corona and that of the 'continuous' radiation of the solar photosphere with a wave-length less than λ_0 will be equal to $1{\cdot}3 \times 10^4$ if λ_0 corresponds to the ionization potential of helium and $1{\cdot}4 \times 10^{24}$ if $\lambda_0 = 228$ A. (which corresponds to the second ionization potential of helium). We also assume that in the far ultra-violet the sun radiates as a black body at $T = 5{,}700°$. One may conclude, therefore, that the spectrum of the sun in the region of wave-lengths of the order of a few hundred angstroms must be lined.

Hard coronal radiation which penetrates into the lower layers of the sun's atmosphere will influence the state of ionization of the latter. The observed ratio $\frac{He^{++}}{He^{+}} = 3 \times 10^{-5}$ (where He^{+} and He^{++} correspond respectively to the concentration of once- and twice-ionized atoms of helium in the chromosphere)[2] may be explained by photo-ionization of hard coronal radiation. The most effective lines should be those having wave-lengths of about 228 A. There are bound to be such lines in the far ultra-violet. The transition $3S3d^3D - 3S3p^3P$ of the ion Fe XV gives a group of lines with λ very close to 228 A. (this value of λ is calculated from Edlén's study of the ultra-violet spectrum of Fe XV).

However, the observed ratio $\frac{He^{+}}{He}$ (where He is the concentration of neutral helium atoms in the chromosphere) cannot be explained by this mechanism.

Hard coronal radiation is bound to influence profoundly the earth's ionosphere.

A more detailed discussion of these problems will be given in the *Russian Astronomical Journal*.

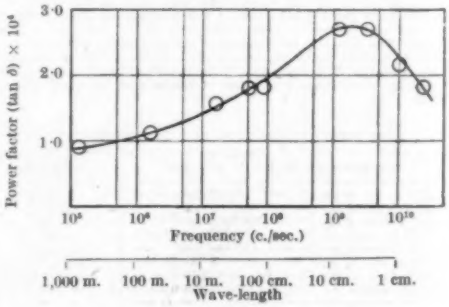
J. S. SHKLOVSKY

Sternberg Astronomical Institute,
Moscow State University.

[1] See *Z. Phys.*, **103**, 536 (1936).
[2] See Unsöld, "Physik der Sternatmospheren", 422.

Dielectric Behaviour of 'Polythene' at Very High Frequencies

THE shortest wave-length at which electrical measurements on 'Polythene' have been published is 10 cm.[1]. These measurements showed that the power-factor increased to a small extent with decreasing wave-length. Measurements have now been made down to a wave-length of 1·23 cm., and the results obtained on a recently manufactured sample of 'Alkathene' supplied by Messrs. I.C.I. (Northwich) are shown in the accompanying figure. It will be noted that the absorption falls fairly rapidly for wave-lengths shorter than about 10 cm. This is of considerable technical interest since it shows that 'Polythene' as at present manufactured may be used with confidence as a low-loss dielectric at wave-lengths as short as 1 cm. with the probability of a further reduction in power factor at even shorter wave-lengths.



These observations also have a bearing on a recent theoretical conclusion by Fröhlich[2], that solid long-chain substances, notably polar ones, should exhibit an absorption band, associated with oscillatory motion of portions of the chains, centred at a wave-length lying between 1/10 and 1/100 cm. and of sufficient width to cause appreciable absorption in the cm. region. On this basis the power-factor would increase with decreasing wave-length towards the far infra-red; the fact that our results show the power-factor to be decreasing at 1·23 cm. suggests that the effect is still small compared with that arising from the loss mechanism operative at longer wave-lengths. The cause of the widely spread basic loss observed is not yet fully elucidated, but there is reason to suppose that it is due, at any rate in large measure, to the presence of polar groups introduced by traces of gaseous impurity in the original ethylene gas. The accuracy of measurement depends on the wave-length but may in general be taken as ± 10 per cent or better.

J. G. Powles

Electrotechnics Department,
University, Manchester.

W. G. Oakes

Research Department,
Imperial Chemical Industries, Ltd. (Alkali Division),
Northwich.
April 13.

[1] Jackson and Forsyth, *J. Inst. Elect. Eng.*, **92**, Pt. iii (1945).
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'Shot-Effect' in Diodes Under Retarding Field Conditions

The magnitude of the fluctuations of current i in a diode valve known as 'shot-effect' obeys the well-known formula due to Schottky[1]

$$\overline{(i - I)^2} = 2eI\Delta f.\Gamma^2, \quad . \quad . \quad . \quad (1)$$

where I is the mean current, Δf is the integrated band-width of the measuring instrument, and e the electronic charge. The factor Γ^2 is theoretically equal to unity under 'saturated conditions', that is, when the potential increases monotonically towards the cold electrode, and under 'retarding field conditions' when it falls monotonically towards that electrode; under usual working conditions, however, the potential has a minimum somewhere between the electrodes and $\Gamma^2 < 1$.

Formula (1) has been verified extensively under saturated conditions, but no satisfactory investigation has been carried out so far under true retarding field conditions owing to the experimental difficulties involved. It can be easily shown that under such conditions in a parallel-plane structure the average current I obeys the law:

$$I = J \exp\left(\frac{eV}{kT}\right), \quad . \quad . \quad . \quad (2)$$

where J is the total emission current from the cathode and V the 'anode potential' (which, of course, is in fact negative). From (2) follows immediately:

$$I\rho = \frac{kT}{e}, \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where

$$\rho = 1/\frac{\partial I}{\partial V}$$

is the differential resistance of the valve. This shows that the product $I\rho$ is strictly constant in the retarding field region and should provide a direct measure of the cathode temperature T.

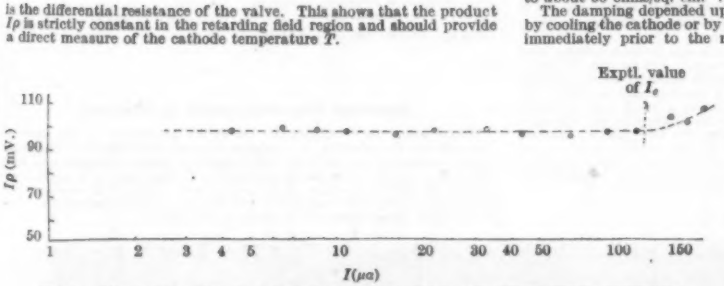


Fig. 1. Examination of valve characteristic under retarding field conditions

One of us (D. K. C. McD.) has carried out experiments with a number of close-spaced diodes, and the accompanying graph demonstrates convincingly that the true retarding region was covered over a wide current range up to a limiting current I_e. The cathode temperature deduced from (3) also agrees satisfactorily with other estimates. The 'shot effect' was then measured under the same conditions and found to satisfy formula (1) with the factor Γ^2 becoming unity for I smaller than I_e. By comparing these results with those of previous workers[2], it appears that the latter had in fact not even reached the true retarding field region in their experiments.

Alternatively, to ascertain under what conditions a true retarding field exists, one may investigate theoretically the potential distribution between the two electrodes of a diode when the cold electrode is negative and thus calculate the limiting value I_e of the anode current for which the potential minimum due to the space-charge will just reach the anode. This has been done by various authors by studying the movement of the individual electrons in their transit from cathode to anode, and also recently by one of us (R. F.) by a statistical method based on earlier work by Laue[3]. The results of both theories agree, apart from a small difference in the numerical factor. For example, in the case of a plane-parallel diode, one obtains for I_e:

$$I_e = C \cdot \frac{(kT)^{3/2}}{e\sqrt{m}} \cdot \frac{s}{d^2} \quad . \quad . \quad . \quad (4)$$

where s is the area of, and d the distance between, the electrodes; m is the electronic mass; C is a numerical constant.

It appears that the limiting value I_e calculated from (4) may be considerably larger (say, up to a factor of 10) than the actual value according to the above-mentioned experiments; this is also evidenced in the work of Möller and Detels[4] directed primarily to the determination of cathode temperature by observing the slope of the logarithm of current (I) against voltage (V) as an alternative to equation (3). The most probable explanation of this fact is to assume the existence of a potential barrier v at the anode surface which would prevent the slower electrons from penetrating into the anode. This would reduce the value of I_e by a factor $\exp\left(-\frac{ev}{kT}\right)$, which for a value of v of approximately 0·2 v. and T about 1,000° K. equals 1/10 approximately, thus enabling agreement to be restored between theory and experiment.

R. Fürth

Department of Mathematical Physics,
University of Edinburgh.

D. K. C. MacDonald

Military College of Science,
Instruments Wing.

[1] Schottky, W., *Ann. Phys.*, **57**, 541 (1918).
[2] For example, Williams, F. C., *J. Inst. Elec. Eng.*, **78**, 326 (1936).
[3] v. Laue, M., *Jahrb. d. Rad. u. Elek.*, **15**, 205 (1918).
[4] Möller, H. G., and Detels, F., *Jahrb. d. drahl. Teleg. u. Telep.*, **27**, 74 (1926).

Total Emission Damping with Space-charge-limited Cathodes

In the course of an investigation of the properties of thermionic valves at high frequencies, made on behalf of the Admiralty in the Valve Laboratories of Messrs. Standard Telephones and Cables, Ltd., I observed in July 1943 a source of energy loss and noise which had up to that time escaped notice. It appears to be of sufficient importance to be taken into consideration in the design of ultra high-frequency amplifiers.

I was, at the time, attempting to measure the energy loss in oxide cathode coatings, and for this purpose had prepared some planar diodes with variable interelectrode spacing and very low inductance connexions. They formed a continuous part of a resonant coaxial line, which was terminated by the anode to cathode space. The damping which was imposed on this line by operating the diodes was measured by the change in Q of the system. The first measurements were made at 3,300 Mc./s.

The effect observed was the occurrence of appreciable damping at high negative values of bias, values considerably in excess of that required to prevent the flow of a measurable direct current. A negative bias of 20 volts made the effect negligible, but at 10 volts it was appreciable, and at 5 volts the effective resistance was about 200 ohms/sq. cm.$^{-1}$ of cathode surface. At 1 volt the effect had increased to about 50 ohms/sq. cm.$^{-1}$. The anode/cathode space was 0·008 cm.

The damping depended upon cathode activity. It could be reduced by cooling the cathode or by drawing a large current for a few moments immediately prior to the measurement to deactivate the cathode. It was not a rapid function of signal-level. A 60-db. increase in signal, making the level a few millivolts, made no definite difference to the magnitude of the damping. It increased with frequency in the decimetre- and centimetre-wave ranges. At low frequencies it was not detectable.

The damping appears to be due to the emission from the cathode surface, which, for the best part, returns to the cathode after making an excursion into the field. It may be a second-order term caused through the finite transit-time of this excursion, and the dependence of the position of reflexion on the phase of the high-frequency field. For these reasons I propose calling it 'total emission damping'. Since the observed damping is the statistical average of the random movement of a large number of electrons, it follows that it behaves too as a source of noise having the general characteristics of 'shot' noise.

Against the disadvantages of 'total emission damping' in the performance of ultra high-frequency amplifiers may be set a possible advantage in its use as a non-destructive means of assessing cathode activity.

The subject is being studied in more detail and it is hoped to publish a full account and theoretical treatment elsewhere.

Publication of this letter has been delayed by security regulations.

C. N. Smyth

New College,
Oxford.
May 12.

A New Type of Focusing X-Ray Monochromator

FOLLOWING up a suggestion which arose during a conversation with Dr. T. Ll. Richards recently, I have been experimenting with a new type of focusing X-ray monochromator. The material used is single texture copper strip, as described by Cook and Richards[1,2]. This material has a very high degree of preferred orientation, with a <100> direction lying in the rolling direction, and a {100} plane in the strip surface. The orientation is suitable for curved monochromators set to reflect 200, and since the copper can be bent and ground much more easily than the crystals usually used for this purpose, and is also much more robust, its advantages are obvious. The reflected beam is quite intense and can easily be traced with a fluorescent screen.

The development of this type of monochromator is continuing, and fuller details will be published later.

W. H. HALL

Metallurgy Department,
The University,
Birmingham, 15.
May 10.

[1] Cook and Richards, *J. Inst. Metals*, **66**, 1 (1940).
[2] Cook and Richards, *J. Inst. Metals*, **67**, 203 (1941).

Two Relativistic Models of Dirac's Electron

THE view has often been expressed that some at least of the difficulties encountered in the quantum-mechanical theory of the electron arise from the inadequateness of the underlying classical model. Perhaps some progress might be achieved by substituting a spin particle obeying the laws of relativistic dynamics for the spinless particle used as starting-point by Dirac. At least two different relativistic models of an electron (or, more generally, of any elementary particle with spin, as it seems probable that it is only through the process of quantization that the individuality of different sorts of particles is brought in) may be thus constructed, corresponding to the *first* and the *second cases* dealt with in earlier communications[1]. I shall only comment here on the *second* model.

This consists of a unipole-dipole singularity moving with the velocity of light according to the laws of relativistic dynamics. The essential point, however, is that it is not the singularity itself, but rather its mean position—or the small circle on which it moves—which has to be considered as representing the electron. The following is a list of some analogies and some promising differences between my *second model* of an electron and its quantum-mechanical counterpart. (*a*) $\mathbf{G}$ has ceased to be parallel to $\mathbf{v}$ just as in Dirac's theory, where the linear momentum and the velocity have different operators. (*b*) The scalar velocity of the singularity is always c, whereas the scalar velocity of the circle as a whole may acquire all values between 0 and c. (*c*) In both theories the moments of momentum are not constants of motion by themselves but they may be easily supplemented in such a way as to acquire that property; the additional terms involve the vector of angular momentum or its operator which are thus introduced in a very similar manner. It might be objected that the above items are expressly brought in to stress the analogy, but in any event the following come out quite automatically, according to the rules of the theory of relativity and without any new arbitrary assumptions. (*d*) If we put M_σ equal to the mass of an electron and s_σ equal to $\hbar/2$, the frequency of revolution around the circle will be just equal to the frequency of Schrödinger's *Zitterbewegung*; and (*e*) the proper diameter of the circle $2r_\sigma = \hbar/M_\sigma c$ becomes equal to the maximum accuracy with which the position of a particle of mass $M\sigma$ can be ascertained. The amplitude of the *Zitterbewegung* has the same order of magnitude. (*f*) Two isotropic tensors, namely, w^α, for which $w_\alpha w^\alpha = 0$, and $s^{\alpha\beta}$ for which $s_{\alpha\beta}s^{\alpha\beta} = 0$, play a dominant part in our theory; it is well known that isotropic four-vectors and isotropic four-dimensional bivectors are closely connected to spinors.

(*g*) The motion of the spin singularity in an electromagnetic field is far more complicated than in a field-free space, but as a first approximation, if the intensity of the field is small enough, we may go on speaking of motion in a circle even in an electromagnetic field, the circle being subject to a small acceleration as a whole and to slight deformations. Obviously the inequality to be fulfilled by the intensity of the field may be obtained by expressing the fact that in the rest system of the circle the displacement of the centre of the circle during the time of one revolution should be vanishingly small in comparison with the proper radius of the circle. The resulting inequality (in the case of an electrostatic field of intensity E)

$$\varepsilon E\hbar \ll M_\sigma^2 c^3,$$

is just the same as the condition of no jumps from positive to negative energy states in Dirac's theory.

(*h*) *Variability of mass and pair production.* Strictly speaking, all that has been said hitherto lacks real foundation so long as we have not proved that M_σ is a constant of motion, and that it may hence be put equal to the mass of an electron. Less restrictively, the question may be put as follows. At the outset, let the electron move in a field-free space; it is then represented by a circle of constant proper radius r_σ, constant mass M_σ and constant spin s_σ. Now, let the electron enter an electromagnetic field and, after remaining there for a while, get out of it into a field-free space again; there it becomes once more a regular circle (the rest-system of which is in general different from what it was before passage through the field). But do M_σ, and hence r_σ and s_σ, return to their previous values? Strictly speaking, the answer is in the negative, but it may be proved that M_σ is approximately constant when the field fulfils a certain condition, which for the field of a plane monochromatic wave of frequency ν reduces to the inequality

$$h\nu \ll 2M_\sigma c^2.$$

Thus we see that the condition of constancy of mass in the classical theory is equivalent to the condition of non-production of pairs in quantum-mechanics. In other words, it may be expected that it is only through the process of quantization that the mass of the electron becomes constant—so long as it is not created or annihilated by pair production.

It is not at all clear how the quantization of our relativistic model has to be performed. In any event, it will have to be done in a very different manner from the present one, for Schrödinger's *Zitterbewegung* is a consequence of the superposition of states of positive and negative energies: to-day we imagine that a particle is either in a state of positive or in a state of negative energy, whereas our circular model of an electron, being a model of the *Zitterbewegung*, must correspond simultaneously to states of positive and of negative energies.

The full details of the theories referred to in this and earlier communications will be published in five papers in the first post-war issue of *Acta Physica Polonica*.

JAN W. WEYSSENHOFF

Institute of Theoretical Physics,
Jagellonian University,
Cracow.
Jan. 3.

[1] *Nature*, **157**, 766, 809 (1946).

Deflexion of Light in the Gravitational Field without using Einstein Geometry

IN a communication in *Nature*[1], Cheng has shown that the advance of perihelion can be easily obtained from a classical Lagrangian with contraction of length and time in the gravitational field but without the use of the Einstein geometry. Applying this same result to a beam of light passing through the sun's surface with $h = r^2\dot{\theta}/c^2 \doteq r_\theta c$, it is found that the deflexion angle would be 2·61″.

The equation of path is

$$\frac{d^2\mu}{d\theta^2} + \mu = \frac{GM}{h^2} + 3\lambda\mu^2.$$

The approximate solution to the first order of GM/c^2 is

$$\mu = \frac{1}{r_\theta}\cos\theta + \frac{GM}{h^2}\,(5 + \cos(\pi + 2\theta)).$$

Therefore, the angle of deflexion ε is obtained from the equation

$$\mu = \left\{\cos\left(\frac{\pi}{2} + \frac{\varepsilon}{2}\right) + \frac{GMr_\theta}{h^2}\,(5 - \cos(\pi + \varepsilon))\right\}\frac{1}{r_\theta} = 0$$

$$\varepsilon = \frac{6MG}{r_\theta c^2} = 2{\cdot}61''.$$

This result seems in better agreement with corrected astronomical data than Einstein's original value, which is only two thirds of the above value.

SU-CHING KIANG

Department of Physics,
National University of Chekiang,
Meitan, Kweichow, China.
March 16.

[1] Cheng, *Nature*, **155**, 574 (1945).

Statistical Thermodynamics of Mixtures

FROM some work employing the Bethe technique, I deduced[1] a formula for the number of configurations of mixtures of p-mer and single molecules on a lattice. Afterwards, a kinetic derivation of this formula, together with its generalization to the case of a mixture of simple or branched chain molecules of any number of species, was given by Guggenheim[2] using the principle of detailed balancing. The formula in question can be written in the form:

$$\log g(N_i) = \tfrac{1}{2}z\log(\Sigma q_i N_i)\,! - \sum_i \log N_i\,! - (\tfrac{1}{2}z - 1)\log(\Sigma r_i N_i)\,! + \sum_i N_i \log \rho_i \quad . \quad . \quad (1)$$

where $q_i z$ is the number of sites which are closest neighbours of a molecule of species i which contains r_i submolecules (a slight modification of the definition covers the case of flexible open-chain molecules which can bend back on themselves), and the other symbols have their customary meanings. The value of q_i is given by

$$z(r_i - q_i) = 2(r_i - 1) \quad (\text{all } i) \quad . \quad . \quad (2)$$

In my work only simple chain molecules were considered. Guggenheim's derivation is equally applicable to molecules with branched chains as to simple-chain molecules, but "the exclusion of molecules having closed rings is an essential condition" for Guggenheim's argument. It would therefore be expected that the formulæ obtained by

him would not be applicable to mixtures containing such molecules. Consideration of closed-ring molecules in connexion with another problem has, however, shown that equation (1) is still formally applicable to mixtures which contain such molecules, although the parameter q no longer has the simple physical significance which it has in the case of chain molecules and r has to be defined as the number of sites occupied by the closed-ring molecule and not as the number of submolecules of which it is built.

A small closed-ring molecule, such as a benzene ring, was considered. It was pictured as occupying a group of five sites which consisted of a given site and four of its closest neighbours. The Bethe technique was used to consider a mixture of N_d such disk-shaped molecules and N_1 small molecules each of which occupied one lattice site with N_v vacant sites. It was found that the combinatory factor, which will be denoted by $g(N_d,N_1,N_v)$, was given by

$$\log g(N_d,N_1,N_v) = \tfrac{1}{2}z(N_1+N_v+(5z-8)N_d/z) \log(N_1+N_v+(5z-8)N_d/z) - N_1\log N_1 - N_v\log N_v - N_d\log N_d - (\tfrac{1}{2}z-1)(N_1+N_v+5N_d) \log(N_1+N_v+5N_d). \quad (3)$$

It is easily seen that this is the general formula of equation (1) with r_1 and r_v each put equal to unity, and r_d put equal to five, the number of sites occupied by each disk-shaped molecule. It should thus be noted that to cover the case of such molecules the parameters r of equation (1) need to be defined as the number of sites occupied by the molecules of the different species, instead of as the number of submolecules of which they are built. It should also be noted that although zq_d is still defined formally by equation (2), it can no longer be given the simple physical interpretation, which it has in the case of chain molecules, of the number of closest neighbours of the complex molecule. The number of sites which are closest neighbours of one of the closed-ring molecules under consideration is $5z-12$, whereas the value of zq_d is $5z-8$.

It is proposed shortly to publish the analysis on which the foregoing remarks are based.

A. R. Miller

27 Lancaster Terrace,
London, W.2.

[1] *Proc. Camb. Phil. Soc.*, **39**, 54 (1943).
[2] *Proc. Roy. Soc.*, A, **138**, 203 (1944).

Extension of the *A—X* System of Nitrogen

This inter-system transition discovered by Vegard in solid nitrogen and by Kaplan in gaseous nitrogen[1] has been examined more recently by Wulf and Melvin[2] and by Janin[3]. Only the $v'=0$ and 1 progression have been analysed with some detail. The $v'=2$ progression is much less intense and was reported only by Kaplan, who has observed the (2,5), (2,6) and (2,7) bands.

Bands of this system were found in the night sky emission with great relative intensity; this system seems much more developed here than in the laboratory experiments, since Cabannes and Dufay[4] think that they have observed the progressions from $v'=0$ to $v'=6$ or 7.

The bands of this transition that I have observed from 2100 A. to 4300 A. are given in the accompanying table.

In the visible spectrum, they are often overlapped by the second positive bands and rather difficult to separate from them. In the ultra-violet part, it is much easier to observe the $v'>1$ bands, as can be seen in the spectrogram, where the (2,6), (2,7), (3,5), (3,6), (4,5) (4,7), (4,8) bands are fairly clear.

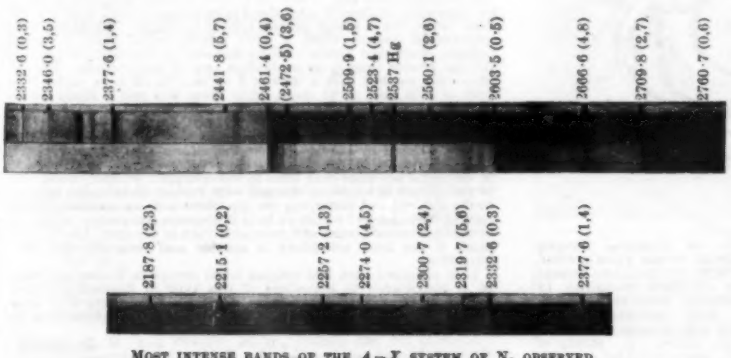
The wave-numbers of the observed bands are in agreement with Janin's formula but not with Herzberg's formula and Bernard's measurements[4].

Renée Herman

Observatoire de Lyon.

[1] Kaplan, J., *Phys. Rev.*, **45**, 675 (1934).
[2] Wulf, O. R., and Melvin, E. H., *Phys. Rev.*, **55**, 687 (1939).
[3] Janin, J., Thèse, Paris, 1946, private communication.
[4] Cabannes, J., and Dufay, J., private communication, *J. Astrophys.*, in the press.
[5] Kaplan, J., *Phys. Rev.*, **45**, 898 (1934). Bernard, R., Thèse, Paris, 1940; *Ann. Phys.*, **13**, (ii) (Jan.-Feb. 1940).

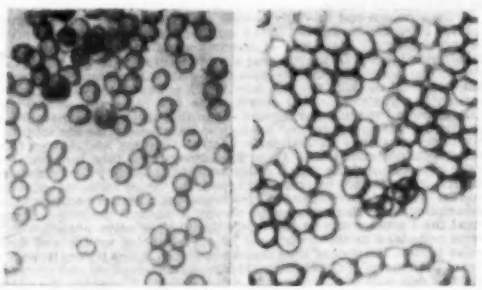
v''	2	3	4	5	6	7	8	9	10	11	12	13	14	15
$v'=0$	2215·1	2332·6	2461·4	2603·5	2760·7	2935·7		3151·5	3601·9	3887·9				
$v'=1$	(2146·6)	2257·2	2377·6	2509·9	2655·6	2817·1	2997·0	3198·0	3425·2	3682·4	3977·9			
$v'=2$		2187·8	2300·7	2424·4	2560·1	2709·8				3501·9	3766·9	(4071)		
$v'=3$		2123·5	2229·9	2346·0	(2472·5)						3581·8	3855·2	(4169)	
$v'=4$			(2164·5)	2274·0		2523·4	2666·6						3948·1	4272·3
$v'=5$				(2207·2)	2319·7	2441·8	2576·0							



Most intense bands of the $A-X$ system of N_2 observed between 2760 and 2150 A.

Induction of 'Gigas' Forms of *Penicillium notatum* by Treatment with Camphor Vapour

Camphor has been reported by Bauch[1] to be effective in inducing polyploidy in fungi. Thaysen and Morris[2] succeeded in producing a giant strain of *Torulopsis utilis* by treatment with camphor vapour. It was therefore determined to test the effect of camphor vapour on *Penicillium notatum* strain N.R.R.L. 1978 *B*. The procedure was to add different amounts of camphor to flasks each containing 25 ml. of sterilized 3 per cent malt agar. The agar was then poured into Petri dishes of 100 mm. diameter. The cultures on the plates to which 75 mgm. of camphor had been added showed a distorted growth. Conidial formation was delayed but after twenty-two days some spores were formed. When these were examined microscopically, some of the spores were found to be larger than the others, whereas spores from control cultures were uniform in size. Spores from the treated and control cultures were plated out on malt agar by the dilution



a *b*

Spores from (*a*) a standard and (*b*) a 'gigas' strain mounted in gum chloral (× *c.* 1,000).

method. There were no macroscopic differences between the colonies from the control and treated samples. When examined for spore size, however, thirty colonies from the control series were found to have spores of the same size, whereas, out of forty-four colonies from the treated samples, thirty-five were like the controls, five had spores larger than the controls and four had a mixture of large and average sized spores. Isolations were made from these large-spored colonies and 'gigas' lines established. Fig. *a* shows spores from a normal line and Fig. *b* spores from a 'gigas' line, three months after isolation and after being subcultured four times. The change thus appears to be permanent. Camphor treatment has been shown to induce polyploidy in higher plants[3], and since pollen grain size has been found to be a useful criterion of polyploidy, it is probable that the 'gigas' forms with larger spores in *Penicillium* are polyploids.

Penicillin production by the 'gigas' forms in surface culture, using the standard commercial media, appears to be the same as that of untreated controls and camphor-treated controls with spores of average size. It is possible, however, that if 'gigas' forms are obtained in other strains they may react differently with regard to penicillin production. Furthermore, the behaviour of 'gigas' strains requires testing in deep culture media.

Further investigations are being made on the physiology of the 'gigas' strains and also on the question of whether they are actually diploid strains as seems probable.

EVA R. SANSOME

Department of Cryptogamic Botany,
University, Manchester.
May 23.

[1] Bauch, R., *Naturwiss.*, **29**, 503 (1941).
[2] Thaysen, A. C., and Muriel Morris, *Nature*, **152**, 526 (1943).
[3] Levan, Albert, and Gunnar Ostergren, *Hereditas*, **29**, 381 (1943).

Communication Between the Dorsal Edge of the Mantle and the Stomach of *Tridacna*

THE part of the mantle edge of *Tridacna* which is reflected upwards and forwards round the exhalant chamber is highly muscular, greatly thickened and harbours myriads of zooxanthellæ (7 μ each) in the connective tissue. During the study of the food and feeding habits of this form[1], it was noticed that appreciable numbers of free zooxanthellæ invariably occur in the stomach, especially of big specimens. The presence of zooxanthellæ in the stomach of *Tridacna* was previously recorded by Boschma[2] and Yonge[3]. The latter author concluded that such zooxanthellæ were introduced accidentally through handling after the animal was opened for examination.

Microscopical examination of serial sections of *Tridacna* revealed the presence of a remarkable tube system establishing a communication between the stomach and the regions of the mantle edge where the zooxanthellæ thrive.

At the stomach end this tube system starts as a single trunk arising medially from the dorsal wall of the stomach. This trunk goes dorsally and posteriorly in the midst of the numerous digestive diverticula. In the dorsal region of the visceral mass it bifurcates to left and right tubes. The accompanying diagram shows the main trunk and right tube in its full course. The left tube, which is omitted save for a short portion, has a corresponding course. The two tubes run posteriorly fairly close to the muscular septum separating the visceral mass from the greatly enlarged kidneys. Each tube then penetrates the septum, traverses the kidney in a slightly ventral direction and leaves this organ at its posterior third. From the kidneys each tube runs parallel to the gill axis until the region of the adductor muscle, where it swings slightly inwards, to become embedded in the investment of this muscle. With this investment it goes round the posterior surface of the adductor muscle, thus coming to occupy a vertical position. Going round the adductor muscle each tube gives off a main branch which keeps embedded in the investment of the adductor muscle and thus comes to lie in the floor of the exhalant chamber, where it runs forwards almost to the level of the kidneys. It then slants outwards and upwards into the side wall of the exhalant chamber until it reaches the thick region of the mantle edge in front of the exhalant opening. Here it divides into two branches (*a* and *b* in diagram) which go to the two anterior lobules of the mantle edge. Fairly close to its point of origin this main branch gives off a very fine one which also runs forwards but remains in the floor of the exhalant chamber. After giving off this first main branch, the tube continues its course, going first to the edge of the investment, from which it passes dorsally into the neighbouring side wall of the exhalant chamber. In this new position it gives off a second main branch which goes to the posterior region of the mantle edge (*f*). A short distance from the point of origin of this last branch another is given off, which in its turn also goes to the thickened mantle edge (*e*). In the last stage of its course the tube is embedded in the basal part of the thick edge and here it finally divides into two branches (*c* and *d*).

This tube system has a distinct epithelial lining with an equally distinct muscular investment outside it. Its lumen decreases gradually from the trunk to the branches in the mantle edge and naturally varies with the size of the animal. The diameter of the trunk in a specimen 5 cm. in length is about 200 μ. That of the tube just before branching in a specimen 10 cm. in length is 250 μ.

In the mantle edge each of the above-mentioned branches terminates in a number of smaller ones which at their ends have very delicate walls which merge insensibly into the delicate connective tissue harbouring the zooxanthellæ. This mode of termination also holds good for the fine branch ending in the floor of the exhalant chamber.

Invariably the lumen of this tube system contains numerous free zooxanthellæ. No other formed elements or debris have ever been observed mingled with these zooxanthellæ.

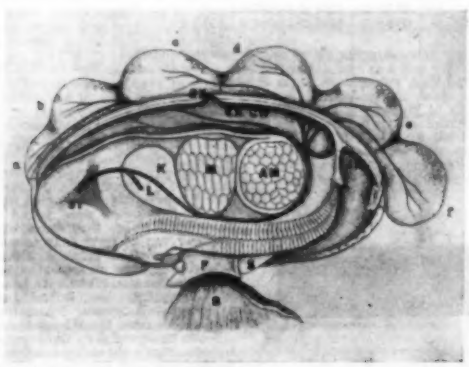
The fact that this tube system connects the stomach with the regions of the body where the zooxanthellæ are abundant, together with the fact that the zooxanthellæ are invariably present in the lumen of this system, indicates that in all probability this tube system is the route along which the transport of the zooxanthellæ to the stomach takes place. In the stomach the zooxanthellæ showed no signs of being digested, nor were they ingested. From this region they are passed to the outside quite unaffected; possibly to infect new hosts and repeat the cycle.

Details of the histology of this remarkable system, its relation to other systems of the body (especially the hæmocœlic system) as well as its morphological and biological significance will be dealt with elsewhere.

K. MANSOUR

Department of Zoology,
Faculty of Science,
Fouad I University,
Cairo.

[1] Mansour, K., *Proc. Egypt. Acad. Sci.*, **1** (1946) (in the press).
[2] Boschma, H., *Proc. Acad. Sci.*, Amsterdam, **27**, 13 (1924).
[3] Yonge, C. M., Great Barrier Reef Expedition Sci. Rep., **1**, No. 11 (1936).



SEMI-DIAGRAMMATIC REPRESENTATION OF *Tridacna elongata* SHOWING THE TRUNK AND THE RIGHT PART OF THE TUBE SYSTEM. THE LEFT MANTLE LOBE TOGETHER WITH ITS VENTRAL AND DORSAL EDGES IS REMOVED; THE EXHALANT CHAMBER IS SHOWN IN LONGITUDINAL SECTION WITH ITS SPECIAL MUSCLES OMITTED. *a–f*, branches in the mantle edge; *A.M.*, adductor muscle; *B.*, byssus; *EX.*, exhalant opening; *EX. CH.*, exhalant chamber; *F.*, foot; *I.N.*, inhalant opening; *K.*, kidney; *L.*, stump of left tube; *M.*, retractor muscle; *S.*, inter-branchial septum; *ST.*, stomach.

Movements in Culture of some Sewage-Filter Organisms

SUBMARGINAL banding of various bacteria and protozoa in the covered mounted drop of culture is familiar. It is due to the organisms seeking the zone of optimum oxygen tension. Certain bacteria and some flagellate and ciliate protozoa, also a nematode worm, retire to the cleft below a glass slip placed on the floor of a suitable culture and form bands or other characteristic aggregations. This centripetal movement has appeared in Petri dishes of clear hay and linseed cultures of mixed sewage-filter organisms. With certain species of ciliates the bands persist for some thirty to fifty days, and the organisms remain abundant in the clefts after they have become very scanty in the open culture.

Paramecium caudatum has been most closely studied and its band remains submarginal, 0·5–1·5 mm. from the edge, for some twenty days. The band then moves inwards and forms a ring farther removed from the margin of the slip. The individuals in the band may number fifty or more to 1·0 mm. of length and the band is distinct to the eye, or they may be sparse. Distance from the margin is not related to density of band. Often they are very orderly, lying touching, aligned in a single row, with the anterior ends inwards. The rather sudden inward migration of the band seems related to an advanced stage in flocculation of the culture bacteria when, presumably, more oxygen becomes available to the ciliates.

When slips 22 mm. square were raised on feet to give clefts graded in height from virtual 0 to 1·12 mm., it was found that the highest cleft was scarcely attractive to *Paramecium*. A cleft of 1·0 mm. attracted large numbers, but inward movement was continuous and relatively rapid and complete dispersal occurred when the culture was fourteen days old. Clefts of 0·15–0·55 mm. attracted numbers in proportion to height, and the aggregations in each followed the same course but at speeds directly related to height. This course was: submarginal narrow band, a more central broad band, a central uniform cloud, and finally uniform dispersal in the clefts of numbers still far greater than in an equivalent area of open culture. The last phase was reached with a cleft of 0·55 mm. in 32 days, and with a cleft of 0·35 mm. in 41 days, when there was still a slight central aggregation in a cleft of 0·15 mm.

It is clear that some factor additional to oxygen requirement is influencing this reaction; this appears to be the attraction of carbon dioxide trapped in the clefts below the sunken slips. Carbon dioxide and other weak acids are known to attract *Paramecium*, and conditions in the clefts are more acid than in free culture. Further, if the bulk of the culture is removed, charged with carbon dioxide and returned to the dish without disturbing the slip, there is no mechanical disturbance of the band, but within an hour it disperses completely, conditions in the open culture being now more acid than in the cleft. On the other hand, if the fluid withdrawn is aerated and returned, the band intensifies.

It is supposed that this retiring habit occurs in Nature and must be of importance to organisms of this type in fluctuating waters. Especially should this be the case in sewage filters with their intermittent wettings, for moisture is held in the narrow clefts when the exposed surfaces of the medium are drying.

LL. LLOYD

University of Leeds.
May 25.

Determination of the Velocity Constants in the Polymerization of Vinyl Compounds

THE accepted mechanism for the polymerization of vinyl compounds involves four velocity constants: initiation (k_1), chain propagation (k_2), chain transfer (k_3), and termination (k_4). It is well known that standard methods of investigation give only two relations for the determination of these coefficients. In the absence of any transfer reaction, these relations determine k_1 and one of the ratios k_2/k_4, $k_2/k_4^{1/2}$ according to the order of the termination reaction. Melville[1] has recently described a method which provides another relation between the velocity constants, and hence allows their absolute values to be calculated under conditions such that transfer is unimportant.

We have found that when transfer is appreciable, it is possible to obtain two additional equations by studying the rate of change of viscosity of the liquid vinyl compound during and after irradiation. Thus it now becomes possible to calculate the absolute values of the four velocity constants. A detailed kinetic analysis gives the following relations:

$$\overline{P} = \frac{2k_2}{2k_3 + k_4^{1/2}(k_1 + AI)^{1/2}}, \quad . \quad . \quad (1)$$

$$\frac{d\eta}{dt} = K_m M_0 S^a \cdot \frac{k_2^2}{k_4} \cdot \frac{k_4^{1/2}(k_1 + AI)^{1/2}}{k_3 + k_4^{1/2}(k_1 + AI)^{1/2}} \left(1 + \frac{k_4^{1/2}(k_1 + AI)^{1/2}}{k_3 + k_4^{1/2}(k_1 + AI)^{1/2}}\right); \quad . \quad (2)$$

where P is the mean degree of polymerization, I the light intensity in arbitrary units, A a constant, η the specific viscosity corrected to infinite dilution, K_m the Staudinger constant, and $M_0 S$ the molecular weight and concentration respectively of the monomer.

In these equations, allowance is made for the fact that the initial activation produces chains growing at both ends, while the transfer reaction leads to a chain which is active at one end only. Equations (1) and (2) provide three independent relations between the velocity constants. When the light is cut off, the concentration of active centres falls to its equilibrium value in the dark reaction. As a result there is a photochemical after-effect, of magnitude $\Delta\eta$, which for high light intensities is given by

$$\Delta\eta = K_m M_0 S \frac{k_2^2 k_3}{k_1 k_4^2(\beta^2 - 1)^2} \left(\beta^2 - \beta + (\beta^2 - 3)\ln\frac{\beta + 1}{2}\right), \quad . \quad (3)$$

where

$$\beta = k_3(k_1 k_4)^{-1/2}.$$

This provides the required fourth relation.

Incidentally, equation (2) indicates a simple means of determining whether chain transfer is important, since in the absence of transfer $d\eta/dt$ is independent of light intensity.

This method has been applied to the polymerization of styrene at 25° C. using light of wave-length 3000–4000 A. In this case the after-effect is sufficiently large to be measurable directly without the use of a sector. The values obtained were: $k_1 = 6{\cdot}0 \times 10^{-12}$, $k_2 = 4{\cdot}5$, $k_3 = 1{\cdot}3 \times 10^{-6}$, $k_4 = 1{\cdot}0 \times 10^8$ litre moles^{-1}sec.$^{-1}$. These figures raise the following points:

(1) In the thermal (dark) polymerization, chain transfer, so far from being negligible, occurs about sixteen times as frequently as bimolecular termination. Thus from (1) the degree of polymerization is nearly k_2/k_3, and its variation with temperature is mainly determined by the value of $E_2 - E_3$, and not by $E_2 - \frac{1}{2}(E_1 + E_4)$, as has been previously assumed[2].

(2) The apparent values of k_1 calculated by previous workers (k_1') may be shown to be given approximately by

$$k_1' = \tfrac{1}{2}k_1 + k_3 k_1^{1/2} k_4^{-1/2}.$$

Here again the second term on the right predominates, and the activation energy previously calculated is not E_1 but $E_3 + \frac{1}{2}(E_1 - E_4)$.

(3) The life of a growing chain is of the order of one minute.

(4) The termination reaction is probably activated. Experiments to determine the energies of activation are in progress, and the method is being extended to other vinyl compounds. Full details will be published elsewhere in due course.

C. H. BAMFORD
M. J. S. DEWAR

Courtaulds, Ltd.,
The Islet,
Maidenhead Court,
Maidenhead,
Berks.
April 4.

[1] Burnett, G. M., and Melville, H. W., *Nature*, **156**, 661 (1945).
[2] See, for example, Melville, H. W., *Ann. Rep. Chem. Soc.*, **36**, 61 (1939).

Non-ideality in some Binary Hydrocarbon Systems

THE properties of non-ideal, binary, hydrocarbon mixtures are of interest both in connexion with the structure of liquids and with theories of solution, because in many of these systems there is little probability of chemical or dipole interaction. Data are available, however, for relatively few non-ideal hydrocarbon systems[1] and the majority of these known systems consist of a saturated component (paraffinic or cycloparaffinic) in admixture with an unsaturated or aromatic component.

It is therefore of interest that recent work in these laboratories, on liquid-vapour equilibrium at atmospheric pressure, has established the occurrence of marked non-ideality, including azeotrope formation, in a series of four binary, paraffinic-cycloparaffinic (naphthenic) systems, systems in which both components are fully saturated bodies and in which azeotrope formation was hitherto unknown.

The first azeotropic system of this type to be detected was apparently that between cyclohexane and 2.4-dimethylpentane[2], which form a minimum boiling azeotrope of boiling point 80·2° C. (at 760 mm.) containing 47·5 mol. per cent of cyclohexane (Fig. 1). The system cyclohexane-2.2-dimethylpentane forms a pseudo azeotrope over the concentration range 0–20 mol. per cent cyclohexane, such that the relative volatility[3] in this region is unity and the boiling point substantially that of pure 2.2-dimethylpentane (79·20° C. at 760 mm.). Recently published work[4] has revealed the existence of a minimum-boiling azeotrope in the system cyclohexane-2.2.3-trimethylbutane (triptane), containing 52·2 mol. per cent of cyclohexane and boiling at 80·15° C. (760 mm.), this data being in substantial agreement with results already obtained here.

Other published work[4] has shown that no azeotrope is formed in the system methylcyclohexane-2.2.4-trimethylpentane ('iso-octane'), but results obtained here indicate that although no azeotrope is formed

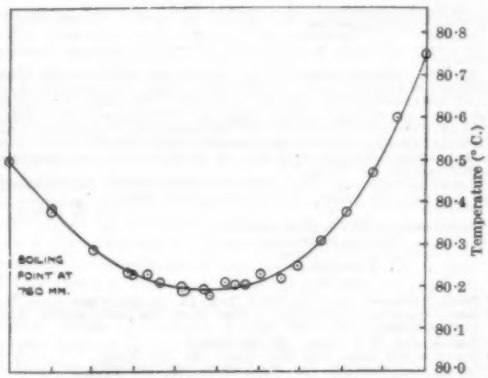


Fig. 1.

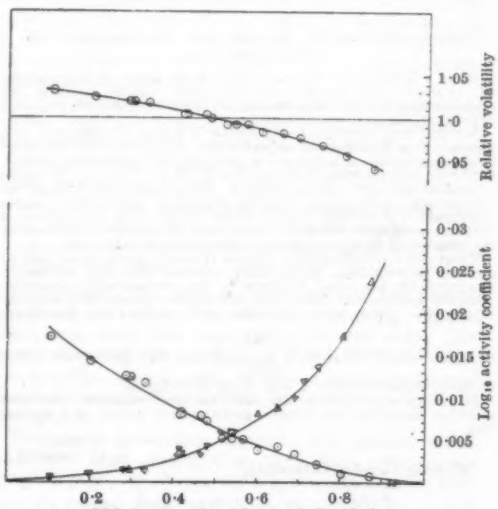


Fig. 2

there is a departure from ideality, as shown by the values of activity coefficients[4] and relative volatilities. The information which is now available for these four non-ideal, paraffinic-cycloparaffinic systems shows them to have broadly similar properties, which can be briefly summarized as follows:

(*a*) The deviations from ideality are 'positive', such that an azeotrope, if formed, is of the minimum-boiling type and the activity coefficients, calculated in the manner of Carlson and Colburn[5] on the assumption that the vapour phase is a perfect gas, are greater than unity. The general shape of the activity-coefficient and other curves given by these systems is illustrated by data for the system 2.4-dimethylpentane-cyclohexane (Fig. 2), which also illustrates the small temperature differences which obtain.

(*b*) Azeotropes are formed only between paraffins and cycloparaffins of very close boiling point, as would be expected[6] in mixtures of compounds of such constitutional similarity. This point is illustrated by the accompanying table.

System	Boiling point of pure component (° C. at 760 mm.)	Boiling point difference (° C.)	Boiling point of azeotrope (° C. at 760 mm.)
Cyclohexane—	80·74	0·23	80·2
2.4-dimethylpentane	80·51		
Cyclohexane—	80·74	0·14	80·15
2.2.3-trimethylbutane	80·88		
Cyclohexane—	80·74	1·54	79·2 (pseudo-azeotrope)
2.2-dimethylpentane	79·20		
Methylcyclohexane—	100·93	1·69	No azeotrope
2.2.4-trimethylpentane	99·24		

(*c*) The volume-changes due to mixing (at 20° C.) in the four systems are so small as to be difficult of precise determination, and in all instances are less than 0·1 per cent. The refractive indices (at 20° C.) of the four systems show an almost exactly (to within 0·05 per cent) linear variation with composition on a volume per cent basis, in agreement with the generalization due to Ward[7], there being no indication of deviation from this rule as was found for many hydrocarbon systems by Herington[8].

I wish to record my thanks to the chairman of the Anglo-Iranian Oil Co., Ltd., for permission to publish these results.

C. B. Collis

Anglo-Iranian Oil Company, Limited,
Research Station,
Sunbury-on-Thames,
Middlesex.
May 14.

[1] Ewell, Harrison and Berg, *Petrol. Eng.*, **16**, (3), 229 (1944).
[2] Birch, Habeshaw and Collis, British Prov. Patent 24302/44, filed Dec. 5, 1944.
[3] Fenske, *Ind. Eng. Chem.*, **24**, 482 (1932).
[4] Harrison and Berg, *Ind. Eng. Chem.*, **38**, 117 (1946).
[5] Carlson and Colburn, *Ind. Eng. Chem.*, **34**, 581 (1942).
[6] Hildebrand, "Solubility of Non-Electrolytes", 128 (2nd Edit., 1936).
[7] Ward, *Ind. Eng. Chem.*, **10**, 569 (1938).
[8] Herington, *Trans. Faraday Soc.*, **40**, 481 (1944).

Cyano-ethylation of Arsines and the Formation of Arsine-amidines

Many examples are known of the direct union of acrylonitrile, $CH_2:CH.CN$, with primary and secondary amines to form the corresponding β-cyano-ethyl-amines, of types $RN(CH_2.CH_2.CN)_2$ and $R^1R^2N(CH_2.CH_2.CN)$ respectively.

We find that acrylonitrile undergoes a similar combination with arsines: thus a mixture of phenyl arsine, $C_6H_5AsH_2$, and two molecular equivalents of acrylonitrile furnishes the crystalline phenyl-*bis*(β-cyano-ethyl)arsine, $C_6H_5As(CH_2.CH_2.CN)_2$. We have prepared a number of such tertiary arsines. The speed with which the acrylonitrile and the arsine combine depends on the particular arsine employed: the reaction usually occurs readily when the mixture of the two compounds is heated, but it may be greatly accelerated by the presence of alkaline catalysts such as sodium methoxide.

These β-cyano-arsines have various synthetic applications that we are now investigating. In particular, we find that they are readily converted by the usual reactions to the corresponding amidines: thus the cyano-arsine formulated above gives phenyl-*bis*(β-amidino-ethyl)arsine, which gives crystalline salts such as the dihydrogen nitrate, $C_6H_5As(CH_2.CH_2.C(NH_2)NH_2)_2$, $2NO_3$. The therapeutic action of these arsine-amidines is now being investigated.

It is noteworthy that the only arsenical amidines previously recorded[1] have had the amidino-group directly joined to a benzene ring.

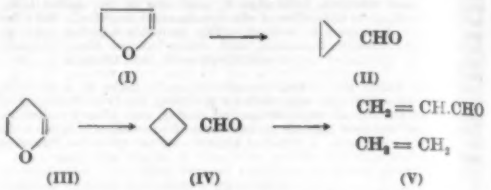
F. G. Mann
R. C. Cookson

University Chemical Laboratory,
Cambridge.
May 14.

[1] Linsker and Bogert, *J. Amer. Chem. Soc.*, **65**, 932 (1943): **66**, 191 (1944).

Fission of 2 : 3-Dihydropyran into Acrolein and Ethylene

It has been suggested[1] that 2 : 3-dihydrofuran (I) on heating above 400° rearranges into *cyclo*propane aldehyde (II). By analogy, 2 : 3-dihydropyran (III) should give *cyclo*butane aldehyde (IV). Experiments have shown, however, that, on heating, dihydropyran does not produce this aldehyde but splits by homogeneous reaction into acrolein and ethylene (V)[2]. Whether the cyclic aldehyde intervenes in the reaction or not must still remain an open question.



(I) (II) (III) (IV) (V)

Dihydropyran is readily prepared by catalytic dehydration of tetrahydrofurfuryl alcohol, and it is surprising that acrolein has not been observed before when this reaction is carried out at sufficiently high temperatures. Kline and Turkevich[3], using a thoria catalyst at 550°, did record the formation of low-boiling material which "polymerized on standing and had a sharp odour", but they failed to identify acrolein. Paul's experience was similar[4]. Experiment has now shown that acrolein is formed if the conditions are right, and the yield can be as high as 62 per cent. It is important to use a selective catalyst which allows the dihydropyran to be rapidly desorbed as it is formed instead of remaining attached to the surface of the catalyst and undergoing further dehydration. The best catalyst for the purpose contains equal amounts of silica and alumina. Active alumina or silica gel catalysts give only hydrocarbon products with little or no acrolein. Basic aluminium phosphate[5], titania or thoria have intermediate activity and give complex products containing some acrolein.

Full details will be given elsewhere.

Christopher L. Wilson

University College,
London, W.C.1.
May 24.

[1] Wilson, *J. Chem. Soc.*, 59 (1945).
[2] Wilson, Brit. P., 569625. Cf., also, Bremner and Jones, Brit. P., 573507.
[3] Kline and Turkevich, *J. Amer. Chem. Soc.*, **67**, 498 (1945).
[4] Paul, R., private communication.
[5] Bremner and McNeil, Brit. P., 547334.

Erosion in the Sudan

Mr. Alexander Howard, in his communication under this heading in *Nature* of February 23, draws a picture of the Sudan, "part desert and barren land, with scarcely a shrub or tree to be found, and otherwise sparsely covered", which is largely incorrect. The area of mixed deciduous forest in the territory exceeds 100,000 square miles in extent, while Acacia savanna forest covers a further 250,000 square miles. Even well to the north of the latitude of Khartoum (16°) rainfall is sufficient to maintain a cover of trees, bushes and grass which is of no small importance in checking erosion of soil by rain and wind. In this northern zone it is only around towns and well centres that one can come across areas which correspond to the picture drawn by Mr. Howard; it is the protection and regeneration of such areas that form one of the objectives of the Soil Conservation Board.

W. L. Marjoribanks
(Chief Conservator of Forests)

Department of Agriculture and Forests,
Forests Office,
Khartoum
Sudan.
April 11.

I am surprised that in his capacity of chief conservator of forests, Mr. Marjoribanks appears to misunderstand the object of my communication, which was not only to stimulate public interest in this subject, but also to stress the serious situation disclosed by the report of the committee appointed by the Government to inquire into this question.

Mr. Marjoribanks contents himself with pointing out that there are 100,000 square miles of deciduous forest land and 250,000 square miles of Acacia savanna forests in the Sudan. He fails to mention that this leaves 650,000 square miles of desert and barren land (once no doubt forested), and it is surely with this immense area that he, as well as I, should chiefly be concerned?

The committee raised several vital questions, and I for one should be interested to know what measures Mr. Marjoribanks proposes to adopt to deal with these. The most important would seem to be as follows: (1) To what extent can erosion be averted by human agency? (2) To what extent has the planting of Mesquite been carried out, and with what result? (3) Has the planting of Eucalypt been attempted, and if so with what result? (4) What answer can Mr. Marjoribanks give to the question raised by the committee as to the evil effect of over-populated areas? (5) What degree of density exists in the mixed deciduous forest areas and in those of the Acacia savanna forests?

A. L. Howard

4 Stanhope Street,
Euston Road, London, N.W.1.

ORIGIN OF LANGUAGE

By Prof. ALEXANDER JÓHANNESSON
University of Iceland

IN *Nature* of February 5, 1944, I gave a summary of my researches regarding the origin of the Ide. languages, as set out in my book "On the Primitive Speech of the Ide. people and their First Home" (published in Icelandic in 1943). I had come to a similar conclusion as Sir Richard Paget had propounded in his work "Human Speech" (1930), that a great part of human speech originated in the speaking organs' unconscious imitation of the gestures of the human body, especially the hands. I succeeded in explaining about 25 per cent of the whole Ide. material (about 2,200 constructed roots). I was interested to see whether my conclusions for the Ide. languages were confirmed or not in the Semitic group and undertook therefore a special examination of Hebrew, which is recorded in *Nature* of October 7, 1944, p. 466. Further researches were then made in an attempt to prove the gesture theory. In one of these, "On the origin of Ide. *eu-*", I undertook to examine all constructed Ide. roots, beginning with *eu-* (as *geu-*, *peu-*, *teu-*, etc.). Most of these roots have a common meaning, namely: to swell, become round, vaulted, curved.

In the diphthong *eu-*, especially in connexion with a guttural (*geu-*, *qeu-*, etc.) we have to see primitive man's imitation of something round, vaulted, curved, etc., whereas the vowel *i* designates something high (or little) and the vowel *a* something flat. Studies of Ide. *eu-* gave the following result: of 196 Ide. roots constructed with *eu-* we see as follows: *Keu-* 25 roots, *geu-*, *greu-*, *gleu-*, (*gheu*), *ghreu-*, etc., 22, *sqeu-* 10, or 57 altogether. These sounds represent a curved movement, and this is also the fact with roots constructed with *r*, *l* or *n* + *eu* or *s* + *eu*. Of these we have (*s*) *l* + *eu-* 22, (*s*) *r* + *eu-* 12, (*s*) *n* + *eu-* 10, *s* + *eu-* 8, altogether 52, and all these roots represent a curved movement, from the palate downwards, in a curved line forwards and upwards. Then we have many roots with labial + *eu-*: *bheu* (*beu*) 19, *meu-* 7, *peu-* 14, altogether 40. Many Ide. roots beginning with a labial can have the meaning 'to swell' (that is, to become round). After coming to this conclusion—that the Ide. primitive man imitated the round, vaulted or curved form or movement with his speech organs, thus making the sound *eu-*, especially in connexion with a guttural, or *r*, *l*, *n*, *s*, and sometimes *b* or *p* (there exist also the combinations dental + *eu* or *eu-* followed by different suffixes)—I went on to examine how the Hebrew language, as representative of the Semitic group, expressed this idea of round, vaulted, curved. The diphthong *eu-* is not known in Hebrew, although many diphthongs existed in pre-Semitic, as many assimilations in Old-Arabic, Aramaic, Akkadic and Ethiopian show. The result of this examination was surprising. In Hebrew also most roots indicating round, or vaulted, are formed with a guttural followed by a vowel + *v* or labial or guttural. Thus we have: *gv-l* be moved in a circle, *gv-r*[1] to turn, *gv-s* a heap, *chv-g* make a circle, *chv-l* turn round, *gv-ph* be hollow, *kv-r* be round, make hollow, etc. By comparing these roots with the Ide. roots, it is seen that, just as in the Ide. languages, the gutturals are especially used in imitating that which is round, vaulted, etc. In Hebrew the *g*-roots total 90, and of these at least 41 designate to turn round, be vaulted, enclose, be hollow, swell, devour, finish, and 10 to cut, and when we consider that many *g*-roots in Hebrew have an abstract meaning, it is evident that the overwhelming majority of these roots commencing with *g*-sounds in Hebrew are created to imitate something round, vaulted, hollow, etc.

In a third investigation I examined the names of parts of the human body in Ide. and in Hebrew, as it may be considered that many of these names date from the first period of man's attempt to speak. *Homo sapiens* must in the first period of speaking have described the surrounding world in a very simple way. He observed the shape or form of the things, that many things were rounded in shape, as the sun and moon, and that many hills and mountains had an oval or curved shape. He observed the arched form of different parts of the human body, as arms, knees and ankles.

In examining the names of parts of the human body we see that most of these describe the form or shape or the activity. A few examples may illustrate this. The lips have their names from their activity, movement or form: Latin *labium* from *lāb-*, as imitation of the sound by imbibing noisily. The belly has its name from the shape 'the vaulted, curved, swollen', or means 'the cut off' (cf. English belly from the root *bhelgh-*, which shows a movement from the lips backwards over the *l*-position to the back of the palate). Russian *čerëvo* 'belly' belongs to *sqer-*, to cut, which shows a curved movement from the palate downwards to the *e*-position and then upwards to the *r*-position in imitation of a curved movement made by cutting with a primitive instrument such as a scythe. Thus the Russian name of the belly originally designates a cut-off part of animals by slaughtering and is later used for a part of the human body, as with many other names in different languages.

The most important words for arm and elbow (upper arm or lower arm) mean curved, vaulted (as in English elbow, the first part of which belongs to *elei-*, to bend, where *el-* represents a bent movement upwards) or to stretch out (as in Old-Indian *hasta*, from the root *ghasto-*, which represents a horizontal line, or outstretched from the palate, through the *a*-position forwards to the teeth) or to be straight (as in the root *steigw-*, represented in Armenian *t'ekn*, arm, shoulder, where the high vowel ī with guttural represents the straight line.

The Ide. roots, from which names for the parts of human body are formed, are about 320 or a seventh of the whole material. Most of these have the original meaning of round, vaulted, curved, straight or flat. Those indicating round, vaulted, curved are either formed with the diphthong *eu-*, especially guttural +*eu-*, or these roots end with the sounds *r*, *l* often followed by a suffix, which is a later addition. Thus we have the roots *gel-*, *sqer-*, *sqel-*, *elei-*, *u̯er*, *ker-*, *engu̯-*, *u̯engh-*, etc., and all these sounds are formed by a curved movement of the speaking organs. There are very few exceptions to this rule. The roots indicating flat are formed either with the vowel *a* as in *plāg-*, *pelāq-*, *pelā-*, or with a horizontal movement of the speaking organs as in *pet-*, *spē-*, *dhen-*, *lēp-*, *ghasto-*.

The roots indicating straight are formed either with the high vowel *i* as in *steigw-*, *rēig-*, *reig-*, *dhrigh-*, *pilo-*, or closed with *r* or *l* as in *ster-* stiff, *bhel-* to sprint, *ḱeru-* stiff hair, *kel-* shaft, *er-* to lift.

Of the 320 roots from which names of parts of the human body are formed, I have been able to explain

274 or about 85 per cent which are in full accordance with the gesture theory.

Having come to these results, I went on to examine Hebrew to find out whether these rules prevailing in Ide. were also to be seen in the Semitic group, and I found the rules for Ide. fully confirmed.

Hebrew *gulgoleth* means head or skull. This form is undoubtedly a reduplication of the Hebrew root *gv-l*, which means to move in a circle (cf. Icelandic *kollr* head). Thus we have the same original meaning of the head as in many Ide. words for head, 'round', and we notice that the sound *gv-* has come into existence by a circular or, rather, a half-round movement of the speaking organs.

Hebrew *chek* means palate, belonging to the root *chnk*, which means to anoint the mouth of new-born children with date-juice. In Ide. we can compare *keg-*, *keng-*, *kek-*, *kenk-*, in Ags. *haca* hook, Russian *kógotb* a curved iron-nib, and thus we see an accordance with Ide. both in the form and the meaning. Hebrew *gab* means eyebrow, belonging to the root *gb-b*, which means to vault, be vaulted. In Ide. may be compared *ĝebh-*, *ĝep(h)* jaw, really 'the curved', and *ĝeb* (*h*) branch, really 'the curved'.

Hebrew *qereb-* means intestines, chest, mother's life, formed in a similar way as Ide. *gwer(e)bh*, in Greek βρέφος, which means foster, embryo, and Ide. *gwelbh* mother's life, in Greek δελφύς, the original meaning in both groups being 'the vaulted'.

Hebrew *kaph* means the hollow hand, related to the Hebrew verb *kph-ph*, which means bent, curved, and it is evidently formed like *kap-* in Latin *caput*, which originally meant bowl, cup, in imitation of the curved line from the back of the palate downwards to the *a*-position and upwards to the lips.

Of 78 Hebrew names or parts of the human body, I have been able to explain 61 by means of the gesture theory, or about 80 per cent. This does not mean that the relationship between Ide. and Semitic is a proved fact; but only that the pre-Semitic *Homo sapiens*, like his Ide. counterpart, learned to speak by imitating with his speech organs the gestures of the hands, which was the chief means of communication before the period of the birth of language.

I have come to the conclusion that the third consonant in most Hebrew roots generally is a later addition to a primitive sound—a determinative, corresponding to the Ide. suffixes, because the movement of the speech organs is perfect without this addition, which only gives a fuller definition of what is contained in the first two consonants, or really a consonant+vowel+consonant. This becomes clear when we consider the nature of posture and gesture sounds. Posture sounds are the vowels *a*, *i* and *u* (and *e* and *o*), gesture sounds are all consonants. Two consonants with an interjacent vowel show a movement:

(1) From the palate forwards to the lips or teeth (thus we have guttural+vowel+labial or dental, for example, *qap-*, *k̂ad-*).

(2) From the lips or teeth backwards to the palate (thus we have labial or dental+vowel+guttural, for example, *bheg-*, *dek̂-*); we could call these movements full movements.

(3) From the palate forwards to the *l*, *r*, *n*-position, as these sounds lie very near to one another (especially *l*, *r*) and are produced by lifting the tip of the tongue to the middle- or fore-palate (thus we have guttural+vowel+*l* or *r* or *n*, for example, *k̂el-*, *ker-*, *ken-*).

(4) From the lips or teeth backwards to the *n*, *r* or *l*- position; thus we have labial or dental+vowel +*n* or *r* or *l* (for example, *bhel-*, *bher-*, *bhen-*, *dhel-*, *dher-*, *dhen-*). We could call these movements half-movements.

(5) From the *l*, *r* or *n*-position forwards to the lips or teeth, producing *l* or *r* or *n*+vowel+labial or dental (for example, *lāb-*, *lat-*, *rab-*, *reth-*, *nebh-*, *ned-*).

(6) From the *n*, *r*, *l*-position backwards to the palate, giving *n* or *r* or *l*+vowel+guttural (for example, *neĝh-*, *req-*, *legh-*), and these movements we could, of course, also call half-movements.

There are still other possibilities as, for example, guttural + vowel + guttural, labial + vowel + labial, dental+vowel+dental, *r*+vowel+*r*, and in the same way *l* and *n*. There is the possibility of double consonants at the beginning or ending of a root, and also the many possibilities with vowel+consonant.

From this point of view, and concluding that the third consonant in Hebrew generally is a later addition, we can compare a vast number of Ide. and Hebrew roots.

All these three special examinations, which I hope to publish fully in English, have confirmed the gesture theory as described in my book mentioned above and by Sir Richard Paget in various publications.

AVIATION AND SCIENTIFIC RESEARCH

By Prof. MARCEL GRIAULE
The Sorbonne, Paris

THE Congrès de l'Aviation Française held recently in Paris has given French research workers an opportunity of showing the important role which aviation can take as an instrument in scientific research. A section called "The Application of Aviation to Scientific Research" was formed this year, and a comprehensive survey has been made from numerous reports of new conceptions with regard to various applications.

The fields of research from the point of view of aviation can be placed under three headings: the stratosphere; the atmosphere; and the surface of the earth.

The stratosphere is to the physicists, among others, the region in which cosmic rays are most readily observed. Nowadays it is no longer necessary to confine ourselves to observatories on mountains or small 'laboratories' in the form of sounding balloons. It is only the aeroplane that can remain at high altitudes with observers and a useful amount of apparatus for an appreciable time. French scientific workers consider that in the next few months it will be possible to study the nuclear phenomena of cosmic radiation at 14,000 m. (46,000 ft.) with a useful load exceeding two tons.

The atmosphere abounds with 'aerial plankton' and so is of great interest to naturalists. So long ago as 1920, scientific workers in the United States began to investigate this subject. In Europe, Lucian Berland devised a method of trawling which enables small organisms (insects, spiders) and vegetable matter and inorganic particles to be collected at 5,000 m. (16,500 ft.). The former are present because, being only moderately strong flyers, they are thus unable to resist the up-currents in the air. Studying these organisms will give insight into the distribution of various living organisms and the stocking of certain remote lands, especially oceanic islands.

The currents and composition of the atmosphere, particularly above water, are equally interesting to the hydrobiologist, because water is the medium of transport of great quantities of nutrients.

However, it is the surface of the earth which still attracts the greatest attention, and it is here that the aeroplane is unsurpassed for photographic work. It is unnecessary to state the advantages in speed and accuracy of this method for preparing maps. The French Geographical Institute has been allotted a squadron of special aircraft to prepare within a reasonable period maps of territories overseas.

The immediate rewards of air survey are of a morphological character and are related to physical geography: tectonic phenomenon, erosion, and hydrological events are clearly visible. Aerial photography is used in regular hydrographic surveys to plot the topography of the coast and of the bottom of the sea. It is also considered possible to study sea surges by aerial photography and photogrammetric methods. The evolution of the coast-line by sea erosion can, of course, be readily followed by this means.

In France, aerial photography is being used for the preparation of maps of vegetation (1 : 200,000) for both the pure or applied botanist. This work is undertaken by the National Centre of Scientific Research, and is being used to plot classified forest and other reserves. Overseas, photography will allow the survey of remote and secluded areas of vegetation (different types of forest, savannas, etc.).

Again, photography from the air gives more complete information about the distribution of man on the earth, and is thus of interest to the archæologist, the prehistorian and ethnographer. Aerial photography has proved a trustworthy method of studying the past. By making use of oblique background lighting, it makes clear organisations and communities of thousands of years ago. Father Poidebard, so early as 1925, discovered in Syria the details of the line of contact between the Romans and the desert tribes of the Euphrates region. In his last expedition, finishing in 1939, he constructed a plan of the economic organisation of Upper Roman Syria. The novelty of the method employed consisted in combining epigraphic research with the reconnaissance aeroplane. In the buried ruins found in the desert, the first details that appear when seen from a high altitude are the entrances to the buildings and towns; it is there that important inscriptions are found which fix the date of origin. Aerial photography also allows us to locate ancient remains even when the ground is level; for vegetation generally flourishes more vigorously on the foundations of ancient buildings, mounds and ditches; and it turns yellow more quickly on the sites of paths and walls.

But the earth is above all the setting for human phenomena; migrations, pilgrimages, battles, engagements and deployments of troops may be assessed by studying the photographs.

By means of aerial photographs it is possible to fix the transformations of natural boundaries during annual and seasonal variations due to the rotation of crops. Again, slower variations, digressions, alterations or extensions of certain operations of Nature or man have an insensible effect otherwise difficult to assess: such as the regression of grazing land on the high Algerian plateau, the instability of river banks in the north Cameroons and the shrinking of vegetation in certain tropical countries. It reveals the movements of the subsoil, upon the fertility of which mankind depends.

Aerial photography contributes more than psychological aid to the ethnographist carrying out researches on the ground. It constitutes an incomparable method for investigating the human race, presenting a true picture of its disposition. Aerial photographs are also intelligible to primitive peoples, after a certain amount of instruction, as opposed to maps, which remain a closed book to them. It also penetrates real secrets in revealing hidden villages and clearings in forestry reserves; and more particularly in disclosing the details of walled courts, terraces and enclosures which are hidden from terrestrial exploration. It equally allows the establishment of an exact and detailed topography which may make apparent otherwise inexplicable phenomena on maps (sacred ruins, mythical voyages, etc.).

The aeroplane is one of the most precise tools for scientific research on the progress of human evolution and for examining the natural boundaries of the earth. This task is still only in its early stages. With the aeroplane used on the grand scale, the problem will be completed in decades instead of the centuries which would be required by the classical methods of investigation.

PHYSICAL PROPERTIES OF MICA

MICA is so critical a material for the manufacture of electrical equipment that, during the War, it was often referred to as "*the* most important single war material". Without it there would probably not have been any radio or radar, gun control or detector devices. In peace-time, mica is equally important for it is an indispensable component of many domestic and industrial electrical appliances. It is used in condensers, radio valves, heating elements, X-ray apparatus, electrical machinery, temperature control apparatus, etc., and is preferred to other good electrical insulators because it can also be split easily to any desired thickness. As a component of such appliances it is naturally subjected to all kinds of varying physical conditions and it is therefore essential to have an accurate knowledge of the physical properties of mica.

As an outgrowth of certain tests made in connexion with a military problem, P. Hidnert and G. Dickson have obtained data on the linear thermal expansion, changes in structure, power factors, and effects of heat treatment on thickness, opacity, and colour of micas (*Bur. Stand. J. Res.*, 35, 309; 1945). Fifty samples in all, consisting of five types of micas (muscovite, phlogopite, biotite, ripidolite and zinnwaldite), from different sources and of different qualities, were examined. No chemical analyses were made of the samples.

For the thermal expansion measurements, the fused-quartz tube apparatus of Hidnert and Sweeney (*Bur. Stand. J. Res.*, 1, 771; 1928) was modified, so that short cylindrical specimens of mica could be used. All the thirty samples investigated were under load (about 2 kgm./cm.^{2}) when the measurements were made. Results are given for the linear thermal expansion in the direction perpendicular to the cleavage plane over the range 20° C. to 600° C. (in some cases 700° C.). A few of the phlogopite and biotite samples have extremely high coefficients of expansion, many times that of any other known solid material. These micas, in combination with a metal, alloy or non-metallic material, would, when heated or cooled, produce a large differential expansion or contraction. They are, therefore, most useful as high-

expanding elements in temperature control and indicating devices. They would prove, however, unsatisfactory, yet perfectly good electrical insulators, in applications where large changes in dimensions with changes in temperature are not desired.

The section on changes of structure is contributed by H. C. Vacher. Laue X-ray diffraction photographs were taken of several samples at room temperature and at elevated temperatures. Transitions which occurred in the expansion curves of two of the phlogopite and one biotite sample appear to be related to the structural changes shown in the corresponding X-ray patterns. The structures of the micas are apparently fragmented by heating, the fragmentation being caused by the independent buckling of very thin layers of the micas parallel to the cleavage planes.

The power factors of several phlogopite and muscovite micas at 100 and 1,000 kc./s. were determined by E. L. Hall. The details of the method and equipment used have been described elsewhere (*Proc. Inst. Rad. Eng.*, **32**, 393; 1944). Heat treatment of the samples to 600° C., with or without load, resulted in an increased power factor for the phlogopite micas but only a slight alteration in the power factor for the muscovite micas.

The effect of heat treatment at 800° C. on the thickness of muscovite mica was very marked, being as much as 100–150 per cent increase. A Zeiss micrometer, reading to 0·0001 inch and applying a load of about 1 kgm. between contacts of 8 mm. diameter, was used for the measurement of the thickness of the specimens. The phlogopite micas were more resistant to heat treatment than the muscovite micas. The large increases in thickness of nearly all the muscovite samples were accompanied by changes from clear or translucent to opaque, or from polychrome to metallic colour.

The detailed results show, on examination, that the thermal expansion, power factor and colour are all largely dependent on such factors as the chemical composition, the nature, magnitude and orientation of the crystals, the presence of impurities and heat treatment. It must, therefore, be concluded that none of the species of mica has fixed and reproducible physical properties.

IMPULSE VOLTAGES AND IRRADIATED SPHERE-GAPS

A PAPER by J. M. Meek before the Institution of Electrical Engineers reports the results of experiments made to determine the influence of irradiation on the measurement of impulse voltages with sphere gaps. The impulse breakdown of short gaps between spheres is greatly affected by irradiation and it has been shown already that appreciable errors may be incurred if irradiation is not used with spheres of 6·25 cm. diameter in the measurement of voltages up to 100 kV. peak. Further measurements have now been made up to 400 kV. peak with 1/5 and 1/50 impulse voltage waves of positive and negative polarities, for 6·25 cm. and 25 cm. diameter spheres.

Irradiation by the ultra-violet illumination from the impulse generator spark-gaps has a marked influence on the behaviour of the sphere-gap, in the absence of other forms of irradiation. This factor may explain some of the differences between the results obtained by various investigators in the calibration of the sphere-gap with impulse voltages.

The irradiation provided by the insertion of 0·5 mgm. of radium in the high-voltage sphere has also been examined and found to give satisfactory results. With the impulse breakdown of the unirradiated sphere-gap there is a gradual transition from the voltage which causes breakdown for 10 per cent of the applied impulses to that which causes 90 per cent breakdown, whereas a sharply defined breakdown voltage is obtained when the gap is irradiated. The mean breakdown voltage of the unirradiated gap exceeds that of the irradiated gap by an amount which varies with the gap length. For a 3-cm. gap between 12·5 cm. spheres, breakdown of the unirradiated gap occurs at a mean voltage about 13 per cent in excess of that for the irradiated gap. With larger gaps, for which a difference between the breakdown voltages for positive and negative impulses is recorded when one sphere is earthed, the difference is found to be influenced largely by irradiation. The mean breakdown voltage for an unirradiated gap of 9 cm. between 12·5 cm. spheres is 20 per cent higher than the irradiated value for a positive impulse, and 1·5 per cent higher for a negative impulse. The negative impulse breakdown voltages agree closely with the corresponding values given in British Standard 358, whereas the voltages given for the positive impulse breakdown are intermediate between those obtained in the present experiments for the unirradiated and the irradiated gaps.

It is evident that irradiation is an important factor in the breakdown of other forms of discharge gaps in which corona is not observed to precede breakdown. Also, the breakdown of discharge gaps on the wave-front may be expected to be governed largely by the amount of irradiation present, and though this has been realized by many workers for short gaps, no consideration appears to have been given to irradiation in the measurement of wave-front breakdown for longer gaps.

THE ONTARIO RESEARCH FOUNDATION

THE annual report for 1944 of the Ontario Research Foundation includes a list of scientific publications and papers by the members of the staff, during the fifteen years work of the Foundation, to December 31, 1944. The staff has increased to about a hundred, although war-time projects temporarily increased it well beyond that number. Since its establishment, the Foundation has had a broad range of objectives embracing the study of problems in all types of production, but the greater part of the investigations have been in the industrial field, which its facilities and resources are best adapted to serve. Consultative services, testing, short-term studies and long-term investigations have been undertaken for many Canadian firms, and a feature of the Foundation's work is the independent laboratory investigation in advance of industrial demand of fields which show promise of future importance.

During 1944 the demands made on the Foundation exceeded both the available laboratory space and the supply of competent scientific workers. The director, Dr. H. P. Speakman, points out that one

of the most serious costs of the War to the Allied Nations has been that resulting from an excessive concentration of scientific personnel on production and problems associated with it, and that in future we shall realize more clearly the extent to which fundamental research and the training of young research workers have suffered for the past war years. One result of the war experience is the growing conviction that applied science can solve the problems of peace as effectively as those of war, and Dr. Speakman points out that the Foundation must be prepared to meet the greater opportunities and responsibilities. If it is to attract those people with the necessary scientific qualifications, the minimum of adequate facilities and comfort must be provided. A second problem will be to use wisely the available financial resources and to increase them if possible in initiating and conducting scientific research relating to basic local problems. Such pioneer research should not be dependent on the support of private industry, or encouraged in university departments at the expense of academic pursuits and the sound training of young research workers. The small industrial units widely scattered over Ontario presented a particularly difficult problem, especially in the matter of contact and understanding; to deal with this the Foundation would require a special staff of men with scientific and practical training as well as a capacity for solving human problems.

At the end of the year the Gauge Inspection and Rectification Laboratories were closed, after inspecting, during the period 1940–44, 78,307 new gauges and re-inspecting 23,394. In the Textile Laboratories, the rayon quality control fellowship, supported by Courtaulds (Canada) Ltd., has now operated for thirteen years, and has gradually expanded until practically every type of fabric based on rayon yarn is included. The most important aspect of the technical side of this fellowship has been dye-formula development. Equipment has been designed and installed to enable the laboratory to dye sample fabrics under conditions which adequately reproduce those in industry, and on the basis of this work the commercial formulæ for twenty-two basic shades have been developed, all of which meet quality control standards. The nylon fabric research fellowship, supported by Canadian Industries Ltd., was established in 1943 and the main objective is to co-operate with the experimental manufacturing unit of the company in the study and development of nylon fabrics with various forms and uses.

The work of the Chemistry Division has markedly increased both in volume and significance, and there has been a steady growth of fellowship research. In the Division of Biochemistry the services of the Leather Laboratory have been used by two of the research committees organised by the National Defence Department and the National Research Council, and the main problem with which they have been concerned is an investigation by laboratory methods and by service trials of representative types of outer-sole leather and substitute materials. The Division continued to co-operate with another National Research Council committee in investigating domestic linseed oil with the object of producing a 'shortening', that is, hydrogenated linseed oil in a plastic state, which will withstand storage and heating without developing a characteristic and offensive odour. In the Division of Physiography attention has been given to the preparation of a large map showing the surface characteristics and principal soils of Southern Ontario. Preliminary reports of the agricultural census of 1941 have been used to bring up to date tables and charts relating to the distribution of the population of Southern Ontario. In the Division of Parasitology attention has been given almost entirely to problems associated with the blood parasites of ruffed grouse. A preliminary survey of parasites of fish in Quetico Park was carried out on behalf of the Department of Lands and Forests.

INDIAN WOODS FOR PENCIL MAKING

FROM the Wood Seasoning Section of the Forest Research Institute, Dehra Dun, comes an Indian Forest Leaflet (No. 66–1945 Utilization. For. Res. Inst., Dehra Dun, 1945) entitled "Indian Woods for Pencil Making". It was during the First World War that India became for the first time closed to many of the imports which she had enjoyed with her progress during the nineteenth century. Pencils were one of those imports. Since that period, and as a result, a search for pencil woods was undertaken and has been continued throughout the country. About eighty different species of Indian timbers have been tried by the various pencil factories, but the results cannot so far be regarded as encouraging. First-quality pencil woods, with one exception, have not yet been discovered. As is well known, both England and Germany have had to depend on foreign supplies of woods for the manufacture of the highest grade of pencil, the two chief timbers being American cedar, *Juniperus virginiana*, perhaps the best because of its physical characteristics and whittling property, and the East African cedar, *J. procera*, which is a slightly harder timber. Owing to this latter characteristic, the Forest Products Research Laboratory, Princes Risborough, undertook experiments to improve the whittling properties of *J. procera* by a treatment for softening the pencil slats. Indian factories had had to import these junipers for their first-quality pencils.

The only Indian timber which has proved suitable for high-class pencils is *Juniperus macropoda*, growing in the Baluchistan hills. This is a very high-class wood, as good as the American juniper and better than the East African. Until recently, its extraction had not been a practical economical proposition, as those who have visited the beautiful forests—groves would perhaps be the better term—in the hills beyond Quetta will readily appreciate. It is said to be a slow-growing tree, and the natural forests, artistic as they are to the eye with their rugged branching trees, do not represent the volume of clean utilizable timber which would be forthcoming from sylviculturally managed crops. The Second World War has resulted in the introduction of this high-class wood to the pencil trade—though probably not yet as an economic proposition.

Several treatments have been tried to soften and improve the whittling properties of some of the good so-called second-class indigenous pencil woods with the object of making them suitable for first-class pencils. The treatment consisted of steaming for various periods at different pressures, soaking the wood in a weak alkali solution followed by steaming, and steaming followed by impregnation with oily emulsion.

FORTHCOMING EVENTS

Monday, June 24

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Greencroft Gardens, London, N.W.6), at 7.30 p.m.—Prof. Ph. Gross: "Production of Metals by Distillation".

Friday, June 28

PHYSICAL SOCIETY, OPTICAL GROUP (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 3 p.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT ANALYTICAL CHEMIST (male) in the Government Analyst's Laboratory in Salisbury, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (June 30).

GEOLOGIST in the Geological Survey of Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (June 30).

LECTURER IN CIVIL ENGINEERING—The Secretary, Queen's University, Belfast (June 30).

LECTURER IN GEOLOGY, and a LECTURER IN GEOGRAPHY, at University College, Dundee—The Secretary, The University, St. Andrews (June 30).

PROFESSOR OF PSYCHOLOGY, a PROFESSOR OF EDUCATION, an ASSISTANT PROFESSOR OF PSYCHOLOGY, and an ASSISTANT PROFESSOR OF EDUCATION, at the Men's Institute of Education, Cairo and Alexandria—The Director, Egyptian Education Office, 4 Chesterfield Gardens, London, W.1 (June 30).

LECTURER (full-time) IN CHEMICAL ENGINEERING—The Registrar, Loughborough College, Loughborough, Leics. (June 30).

RESEARCH OFFICERS (Chemists, Botanists, Plant Pathologists, Personal Assistant to the Director), a SMALL HOLDINGS ADVISORY OFFICER, and an ASSISTANT at the Experimental Station, at the Rubber Research Institute of Malaya, Kuala Lumpur—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (July 15).

RESEARCH OFFICER or ASSISTANT RESEARCH OFFICER, Division of Radiophysics, Council for Scientific and Industrial Research, Sydney—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (July 15).

GENETICIST to undertake field research on the selection and breeding of *Hevea brasiliensis* under the Rubber Research Scheme (Ceylon)—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (July 15).

ENGINEER in the Transmitter Section, an ENGINEER in the Receiver and Measurements Section, an ENGINEER in the Audio-Frequency Section, and an ENGINEER in the Recording Section, of the British Broadcasting Corporation—The Engineering Establishment Officer, Broadcasting House, London, W.1 (July 18).

BIOCHEMIST to the Research Department of the Turner Dental School—The Registrar, The University, Manchester 13 (July 29).

LECTURERS IN THE CHEMISTRY DEPARTMENT with qualifications in (*a*) Inorganic Chemistry and Metallurgy, and (*b*) Inorganic Chemistry and Fuels—The Principal, Heriot-Watt College, Edinburgh (July 31).

VETERINARY SURGEONS (9) in the Veterinary Branch of the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Department of Agriculture and Lands, P.O. Box 387, Salisbury, Southern Rhodesia (July 31).

CHAIR OF PHYSIOLOGY—The Registrar, The University, Sheffield (August 1).

PLANT PATHOLOGIST, and an ENTOMOLOGIST, at the Tobacco Research Station, Trelawney, Southern Rhodesia—The Chairman, Tobacco Research Board, P.O. Box 387, Salisbury, Southern Rhodesia (August 15).

LECTURER IN PHYSICS, and a LECTURER IN MATHEMATICS—The Principal, Birmingham Central Technical College, Suffolk Street, Birmingham 1.

SENIOR POSITION in the Intelligence Section (applicants must have a degree in engineering, preferably marine engineering, or naval architecture)—The Secretary, British Shipbuilding Research Association, 5 Chesterfield Gardens, Curzon Street, London, W.1.

HONOURS GRADUATES IN CHEMISTRY or PHYSICS (2, male) to undertake researches on (*a*) bonding of rubber to metals and other materials, (*b*) rubber/fabric adhesion and other rubber technological problems—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Fuel and Power. Twenty-third Annual Report of the Safety in Mines Research Board, 1944. Pp. 30. (London: H.M. Stationery Office, 1945.) 1*s.* net. [1812

A Review of the Literature on Diffusion in Solution and the Estimation of Particle Size from Diffusion Measurements. By Frank H. Holmes. Pp. 69. (Manchester: British Cotton Industry Research Association, 1945.) 10*s.* net. [1812

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 810, Vol. 239: Relaxation Methods Applied to Engineering Problems. By D. N. de G. Allen, D. G. Christopherson, L. Fox, J. R. Green, H. Motz, F. S. Shaw and R. V. Southwell. 7*a*. Biharmonic Analysis as applied to the Flexure and Extension of Flat Elastic Plates; 7*b*. The Elastic Stability of Plane Frameworks and of Flat Plating; 7*c*. Free Transverse Vibrations of Membranes, with an Application (by Analogy) to Two-Dimensional Oscillations in an Electro-Magnetic System; 7*d*. Stress Distributions in Elastic Solids of Revolution. Pp. 419–537. 18*s.* 6*d.* No. 811, Vol. 239: Relaxation Methods Applied to Engineering Problems. 8*a*. Problems relating to Large Transverse Displacements of Thin Elastic Plates. By Dr. J. R. Green and R. V. Southwell. Pp. 539–578. 6*s.* 6*d.* (London: Cambridge University Press, 1945.) [1812

London Shellac Research Bureau. Lac Derivatives as Plasticizers for Amino Resins. By Dr. B. S. Gidvani and N. R. Kamath. Pp. 8. Technical Paper No. 28: Ethers and Ether-Esters of Lac and their Polymerization, Part 3. By Dr. B. S. Gidvani and N. R. Kamath. Pp. 19. (London: London Shellac Research Bureau, 1945.) [1812

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 15, No. 4, March 1944. Compiled by Agnes Elisabeth Glennie, assisted by Janet Long Hall Keuneman. Pp. iv + 239–316. (London: H.M. Stationery Office, 1945.) 4*s.* 6*d.* net. [1812

Other Countries

U.S. Department of the Interior: Geological Survey. Bulletin 930-D: Spirit Leveling in Illinois, 1896–1941. Part 4: Northern Illinois. Pp. iii + 1283–1704 + 4 plates. 45 cents. Bulletin 931-K: The Wild Horse Quicksilver District, Lander County, Nevada. By Carle H. Dane and Clyde P. Ross. (Strategic Minerals Investigations, 1941.) Pp. iii + 253–278 + plates 45–47. 25 cents. Bulletin 932-D: Geophysical Abstracts 107, October–December 1941. Compiled by W. Ayvazoglou. Pp. ii + 123–183. 10 cents. Bulletin 934: Phosphate Resources of Florida. By George R. Mansfield. Pp. iv + 81 + 8 plates. 1 dollar. Bulletin 935-B: Manganese Deposits of Cuba. By Charles F. Park, Jr. (Geologic Investigations in the American Republics, 1941–42.) Pp. iii + 75–98 + plates 21–24. 10 cents. Bulletin 935-E: Nickel Silicate and Associated Nickel-Cobalt-Manganese-Oxide Deposits near São José do Tocantins, Goiaz, Brazil. By William T. Pecora. (Geologic Investigations in the American Republics.) Pp. v + 247–305 + plates 44–50. 1 dollar. Bulletin 935-F: Manganese Deposits in part of the Sierra Maestra, Cuba. By C. F. Park, Jr., and M. W. Cox. (Geologic Investigations in the American Republics.) Pp. v + 307–355 + plates 51–67. 75 cents. Bulletin 935-G: Geology and Manganese Deposits of Guisa-Los Negros Area, Oriente Province, Cuba. By W. P. Woodring and S. N. Daviess. (Geologic Investigations in the American Republics, 1941–43.) Pp. iv + 357–386 + plates 68–77. 45 cents. Bulletin 935-H: Manganese Deposits in Costa Rica. By Ralph J. Roberts. (Geologic Investigations in the American Republics, 1941–43.) Pp. iv + 387–414 + plates 78–80. 15 cents. (Washington, D.C.: Government Printing Office, 1942–1944.) [111

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